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STREPSIPTERA DO NOT SHARE HIND WING VENATIONAL SYNAPOMORPHIES WITH COLEOPTERA: A REPLY TO KUKALOVÁ-PECK AND LAWRENCE[1]

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Abstract.—Kukalová-Peck (1991) and Kukalová-Peck and Lawrence (1993) proposed new characters to support a sister-group relationship between Strepsiptera and Coleoptera based on hind wing venation. Through the use of scanning electron microscopy (SEM) and light microscopy, we have examined these putative synapomorphies in multiple strepsipteran taxa and find discrepancies between the author's presentation of strepsipteran venation and those veins we could observe on the specimens themselves. We find that most of the authors' putative synapomorphies are defined imprecisely and do not consist of discrete character states. While the authors have expressed their results in cladistic terminology, they have failed to use standard cladistic methodology in character evaluation. We object to the authors' use of hypothetical groundplans for defining synapomorphy prior to formal cladistic analysis, the heavy reliance on evolutionary scenarios in phylogenetic inference, the lack of adequate outgroup comparison, and the absence of a simultaneous parsimony analysis of the character data. Based on observational discrepancies and methodological improprieties, we conclude that the authors' putative synapomorphies as currently constituted provide no evidence to support a sister-group relationship between Strepsiptera and Coleoptera.

Kukalová-Peck (1991) proposed new synapomorphies for Strepsiptera and Coleoptera based on hind wing venational characters. These characters were later revised, expanded, and presented in more detail in Kukalová-Peck and Lawrence (1993). Previous to this work, there has only been one character supporting a Coleoptera-Strepsiptera sister-group which has survived scrutiny: the ability to power flight with the hind wings (Kinzelbach, 1971, 1990; Kathirithamby, 1989; Kristensen, 1991) Because the phylogenetic position of Strepsiptera has remained one of the most controversial questions in insect ordinal phylogenetics (Kristensen, 1991), and few characters have been found for its placement among the insect orders, these putative synapomorphies are important and deserve closer scrutiny.

The thrust of Kukalová-Peck and Lawrence's work was towards deciphering the phylogeny of Coleoptera using hind wing venation. They examined 200 specimens from 108 families of Coleoptera and three species of Strepsiptera—*Mengenilla* sp., *Coriophagus rieki,* and *Lychnocolax* sp.—though the actual specimen number was

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[1] This manuscript was originally submitted to the Canadian Entomologist in June, 1994; the journal in which the Kukalová-Peck and Lawrence (1993) paper appeared. Due to unacceptably long delays required to get a final review of this manuscript and await a response from Kukalová-Peck prior to publication, it was subsequently withdrawn.

not mentioned. While the authors' putative synapomorphies should be carefully evaluated in the Coleoptera, Strepsiptera, and appropriate outgroups, we will restrict our specific criticisms to their presence and distribution in Strepsiptera. This is because synapomorphies are statements of shared, derived character state distributions. If it can be demonstrated that a certain character is unobservable or undefinable in the Strepsiptera, then regardless of its occurrence in Coleoptera, there is sufficient reason to reject it as evidence supporting a sister-group relationship between Strepsiptera and Coleoptera.

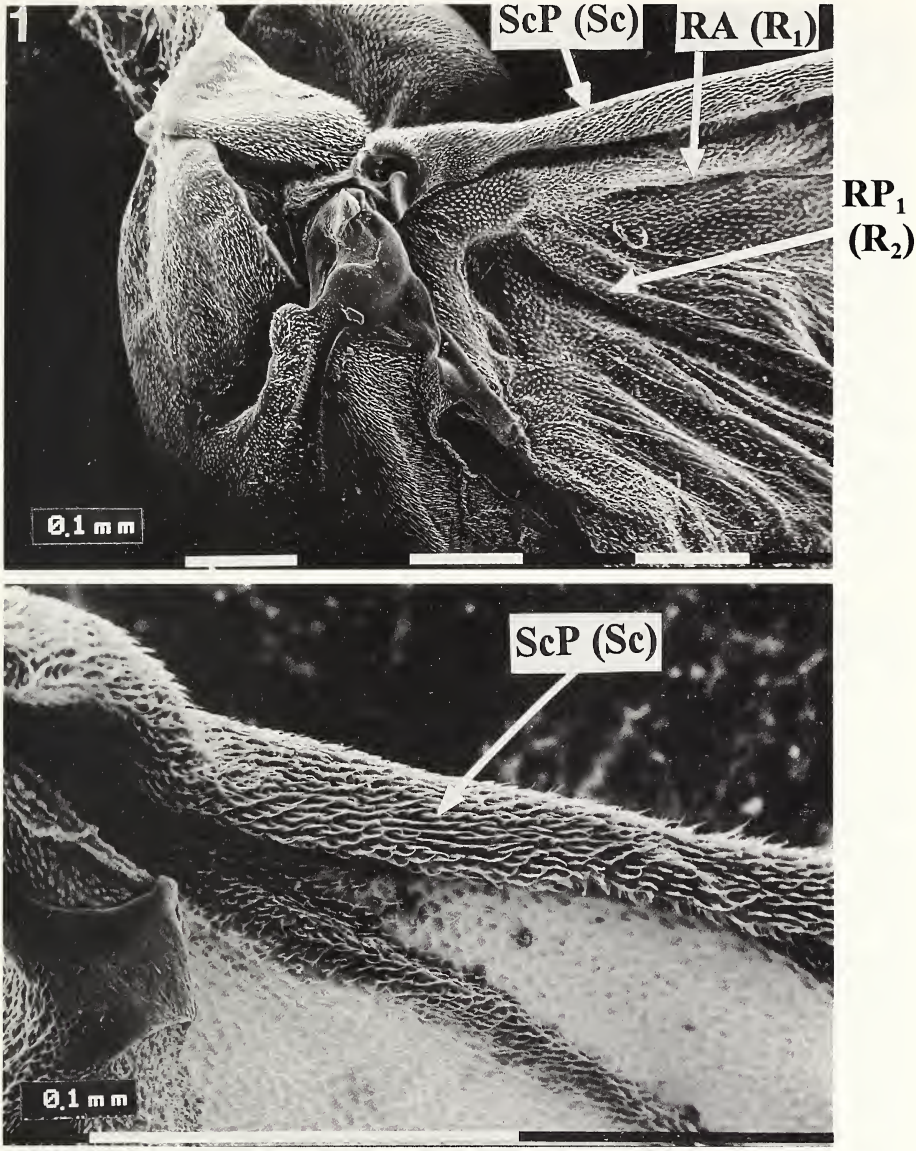
CHARACTER CRITICISMS

We use the following criteria to evaluate Kukalová-Peck and Lawrence's putative synapomorphies: (1) precision of character and state definition e.g., relative size, position, fine structure; (2) whether the states can be defined discretely; (3) distribution of states throughout ingroup taxa; (4) observability of character states in extinct or extant taxa. We agree with Hennig (1966) that only synapomorphy constitutes evidence for monophyly and that symplesiomorphy is phylogenetically uninformative. We further concur with Farris (1990) that non-discrete characters are of little use in phylogenetic analysis because states cannot be objectively defined and state transformations cannot be unambiguously specified. We are therefore concerned that every venational character be defined in such a way as to make the determination of states objective when observing veins on specimens. We further insist that the states be observable in the taxa themselves because inferred states based on preconceived notions of venational evolution in hypothetical prototypes do not constitute prima facie evidence for phylogenetic inference.

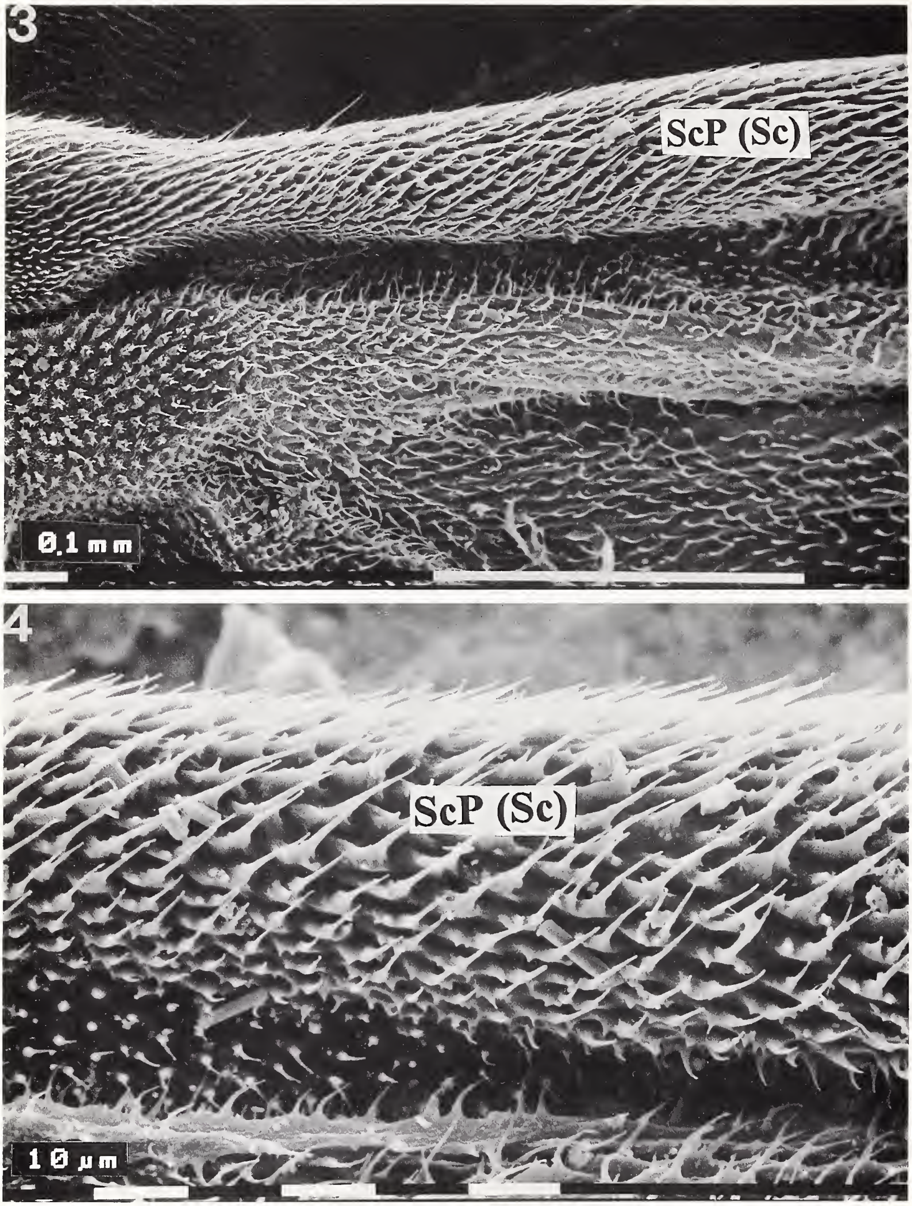
We first provide specific evaluations for each synapomorphy presented by Kukalová-Peck (1991) and Kukalová-Peck and Lawrence (1993). Quotations of original character descriptions (in italics) are followed by the authors' polarity designation. If the same character occurs in both publications, we include both descriptions and polarity designations. Then we evaluate the character and attempt to interpret the states based on the descriptions of the authors. This is followed by specific criticisms of the character and its distribution in Strepsiptera.

Character 1: *A sclerotised and shortened ScP entering the pterostigma* (Kukalová-Peck, 1991; synapomorphy); *ScP ending after entering the pterostigma/radial cell* (Kukalová-Peck and Lawrence, 1993; synapomorphy).

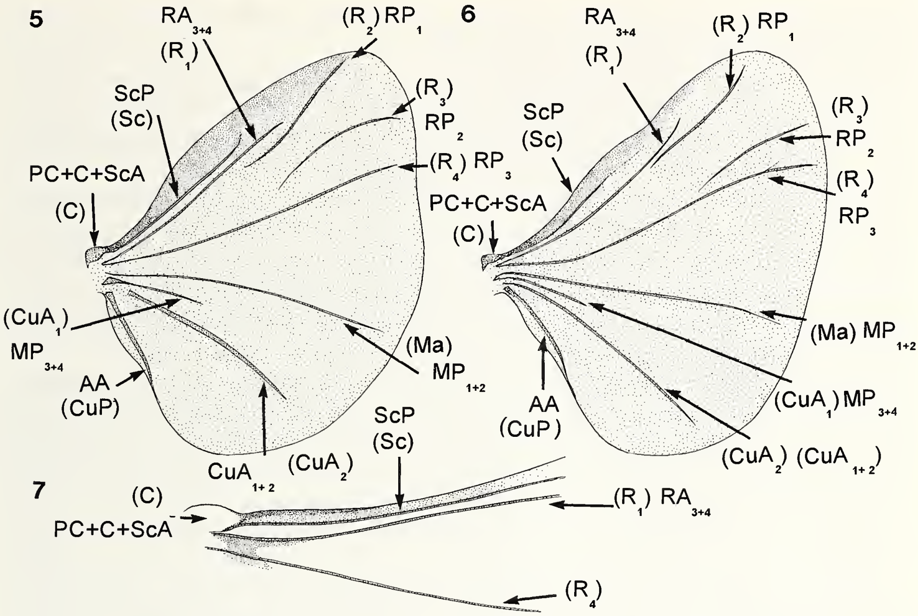
Interpretation: Kukalová-Peck and Lawrence treat C and Sc of Kinzelbach (1971) (Figs. 1–4) as two discrete veins: PC+C+ScA and ScP. According to the authors, ScP runs parallel to the anterior margin of RA and ends abruptly beyond the middle of the wing after entering the pterostigma in Strepsiptera and Coleoptera. They diagrammed PC+C+ScA and ScP as distinct veins visible in the mesothoracic wings of *Mengenilla, Coriophagus,* and *Lychnocolax* (Kukalová-Peck and Lawrence, 1993: figs. 69–71). In the authors' drawings of *Mengenilla* and *Coriophagus,* ScP runs into the strepsipteran "pterostigma" (the darkened region between RA_{1+2} and RA_{3+4}); in the figure of *Lychnocolax* ScP is present but the pterostigma is absent. According to the authors' brief description, the two states of this character are "ScP ending before entering the pterostigma" (plesiomorphy) and "ScP ending after entering the pterostigma" (apomorphy).



Figs. 1–2. SEM of strepsipteran metathoracic wings. Fig. 1 *Coriophagus rieki* Kinzelbach (Halictophagidae), wing base; Fig. 2 *Lychnocolax drysdalensis* Kathirithamby (Myrmecolacidae), costal margin and wings base.



Figs. 3–4. SEM of strepsipteran metathoracic wings. *Coriophagus rieki* Kinzelbach, costal margins. Note that the costal margin apically bears a single vein (Sc), not the two extended veins (PC+C+ScA and ScP) as drawn by Kukalová-Peck and Lawrence (1993) for this species.



Figs. 5–7. Strepsiptera: Corioxenidae. 5, *Corioxenos* sp. (Mexico) Scale of 0.5 mm.; 6, *Loania* sp. (Panama) Scale of 0.5 mm.; 7, *Dundoxenos* sp. (N. Africa) Scale of 0.2 mm. Venational notation in parenthesis after Kinzelbach (1971) and without parenthesis after Kukalová-Peck and Lawrence (1993). Note that the strepsipteran "pterostigma" (the region between RA$_{1+2}$ and RA$_{3+4}$) is absent.

Evaluation: This character relies on two distinct morphological features for its definition: the presence of ScP as a discrete vein and its position relative to the pterostigma. We have examined the same strepsipteran taxa surveyed by Kukalová-Peck and Lawrence as well as other Strepsiptera taxa, including the family Corioxenidae. We failed to observe any vein which could possibly equate to the PC+C+ScA as drawn by the authors in the wings of these taxa. Contrary to these drawings, we could not find this vein using scanning electron microscopy (Figs. 1–4) nor using light microscopy (Figs. 8–10). The authors provide no evidence supporting the supposition that this is a vein, and their interpretation relies on the presence of PC+C+ScA and the compliance this interpretation has with the presumed ancestral state. Since PC+C+ScA cannot be distinguished from ScP, it is incorrect to specify a state for ScP and homologize it with the state in Coleoptera. In the Corioxenidae C+Sc splits to Sc which is a single vein without any darkened region posteriorly (Figs. 5–7). In this family, Sc can be clearly distinguished from C but a subdivision of Sc into ScA and ScP is unobservable and the pterostigma is absent (Kathirithamby and Peck, 1994).

Even if the authors feel justified in equating ScP with Sc of Kinzelbach (1971) (in the absence of observing PC+C+ScA), the distribution of this character is problematic. In Strepsiptera, the posterior margin of Sc commonly does not reach the

pterostigma, and in many taxa the pterostigma itself is absent (see character 8 below regarding the strepsipteran "pterostigma").

Character 2: *The apical part of the anterior* [wing] *margin not strengthened by RA* (Kukalová-Peck and Lawrence 1993; synapomorphy).

Interpretation: The authors provide no criteria for distinguishing a strengthened anterior wing margin from one which is not strengthened. Presumably the states of this character are "strengthened" (plesiomorphy) and "not strengthened" (apomorphy). Until a more precise definition is provided, we cannot evaluate this vague character.

Character 3: *RA and RP diverging abruptly from one another close to the wing base* (Kukalová-Peck and Lawrence, 1993; shared autapomorphic trend).

Interpretation: We presume the states are "not diverging abruptly" (plesiomorphy) and "diverging abruptly" (apomorphy).

Evaluation: The authors present no criterion for what constitutes an abrupt divergence and how it can be distinguished from a non-abrupt divergence. Apparently, there is some angle at which a divergence is abrupt and another at which it is not abrupt, and the two angles do not overlap. If the authors were to argue that the precise angles of divergence (or range of angles) is irrelevant at the ordinal level in insects, then we would likewise counter that this is an irrelevant line of evidence for ordinal level phylogenetic reconstruction. We have observed sufficient variation in the angle of these two veins in Strepsiptera, however, to make us doubt that it can be defined with discrete states (Figs. 5–10). We are further unclear what the authors mean by "shared autapomorphic trend" and how this represents evidence for phylogenetic affinity (discussed below).

Character 4: *Plesiomorphous separation of RA and RP at the wing base* (Kukalová-Peck, 1991; symplesiomorphy?).

Interpretation: The states are apparently "RA and RP basally separate" (plesiomorphy) and "RA and RP basally fused" (apomorphy).

Evaluation: All Strepsiptera and Coleoptera have RA and RP fused basally, as Kukalová-Peck and Lawrence (1993) recognized when they formulated character 3. In the author's "generalized Neopteran wing," these veins are also fused basally. If indeed the separation of RA and RP at the wing base is "plesiomorphous," then how does this symplesiomorphy support the monophyly of Strepsiptera and Coleoptera?

Character 5: *The radial and medial basivenale not fused together into a large plate* (Kukalová-Peck and Lawrence, 1993; shared autapomorphic trend).

Interpretation: The states of this character are presumably "radial and medial basivenale fused" (plesiomorphy) and "radial and basal venale not fused" (apomorphy).

Evaluation: Once again, it is not clear what a shared autapomorphic trend is and how this represents phylogenetic evidence.

Character 6: *RP branches supporting folds* (Kukalová-Peck, 1991; synapomorphy); *the apical field supported by RP branches, which have a somewhat fan-like arrangement* (Kukalová-Peck and Lawrence, 1993; shared autapomorphic trend).

Interpretation: The RP branches are equivalent to Kinzelbach's (1971) R_1–R_4. For the first description, the states are apparently "RP branches not supporting folds" (plesiomorphy) and "RP branches supporting folds" (apomorphy). For the second description, the states are "RP branches not supporting apical field, not fan-like"

(plesiomorphy) and "RP branches supporting apical field, somewhat fan-like" (apomorphy).
Evaluation: The authors need to define clearly what constitutes "supporting." For instance, must RP be directly contiguous to a fold in order to support it or just in the general vicinity of a fold? How far must RP be from a fold before it is considered no longer supporting? Is it possible for a fold to exist in the anterior portion of the wing without coming into contact with RP? The second description assumes that no other insect groups have RP branches in the apical field. The real question, of course, is what is being homologized here. Is it the fact that Strepsiptera and Coleoptera both have folds in the wings? This seems suspect because the system of folds in Coleoptera is quite different from that of Strepsiptera, as the authors have recognized, and we doubt that the folds themselves are homologous. Is the homology implied that only Coleoptera and Strepsiptera have developed a novel way of supporting their folds through the use of RP? This makes the dubious assumption that no other insect has folds that are supported by RP the same way folds are supported in Coleoptera and Strepsiptera. The authors need to clarify what they mean by support and how this type of support is novel to Strepsiptera and Coleoptera.
Character 7: *Reduced CuP* (Kukalová-Peck, 1991; synapomorphy); *CuP reduced* (Kukalová-Peck and Lawrence, 1993; shared autapomorphic trend).
Interpretation: In Kinzelbach's (1971) drawings of strepsipteran wings CuP is a distinct and often large vein. Kukalová-Peck and Lawrence call this vein AA and treat CuP as either absent or extremely reduced in Strepsiptera. The presumed states of this character are "not reduced" (plesiomorphy) and "reduced" (apomorphy).
Evaluation: In the authors' drawings of *Mengenilla* sp. and *Coriophagus rieki* (Kukalová-Peck and Lawrence, 1993: figs. 69–70) CuP is absent and in *Lynocholax* (fig. 71) CuP is present as a small vein basally separate from, and apically fused to AA (CuA_2 of Kinzelbach [1971]). In the numerous *Lynocholax* species we have examined, we have not observed this small vein (Fig. 10), nor have we observed such a vein in any strepsipteran taxa. We see no reason why the large posterior vein in Strepsiptera should be considered homologous to AA rather than CuP, and the authors provide no justification for this designation. Hence there is a serious question of homology between the CuP of Coleoptera and what the authors consider the CuP of Strepsiptera.
Character 8: *A shortened RA forming a pterostigma between* RA_{1+2} *and* RA_{3+4} (Kukalová-Peck, 1991; synapomorphy).
Interpretation: Kukalová-Peck treats the R_1 of Kinzelbach (1971) basally as RA and distally as RA_{1+2} and RA_{3+4}, with the darkened region between these branches as a "pterostigma" homologous to the coleopteran pterostigma. It is not clear whether the synapomorphy is a short RA, the formation of a "pterostigma" between RA_{1+2} and RA_{3+4}, or both. If both, the states are "RA not shortened, RA_{1+2} and RA_{3+4} not forming a pterostigma" (plesiomorphy) and "RA short, RA_{1+2} and RA_{3+4} forming a pterostigma" (apomorphy).
Evaluation: Kukalová-Peck provides no criteria for distinguishing a shortened RA from a non-shortened RA. The varying lengths of RA we have observed in Strepsiptera, however, make us doubt that it can be defined discretely. The formation of a pigmented pterostigma between RA_{1+2} and RA_{3+4} cannot be considered a syna-

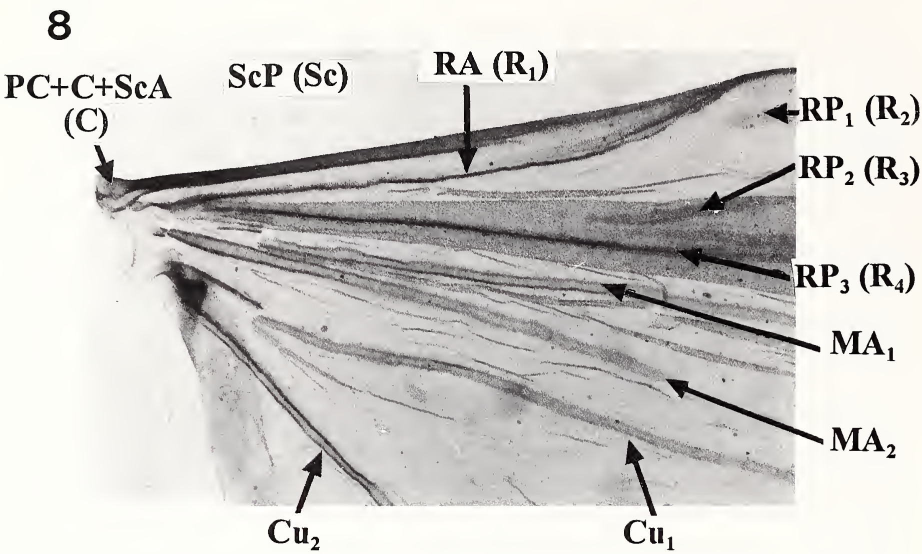


Fig. 8. Light microscope photo of strepsipteran metathoracic wing. Note that RA_{1+2} is absent in *Mengenilla* and *Coriophagus.* Scale: X35.

pomorphy unique to Strepsiptera and Coleoptera since, as the authors correctly recognize, Hymenoptera and Mecoptera possess this state as well.

We have some reservations with Kukalová-Peck's designation of a pterostigma in Strepsiptera. What she has labelled RA, RA_{1+2}, and RA_{3+4} is, according to Kinzelbach, a single vein R_1. In some groups of Strepsiptera its distal margins are laterally expanded and the medial region is somewhat sclerotised. In Corioxenidae Sc is distinguishable as a single vein posteriorally (Figs. 5–7) but R_1 is not laterally expanded and this family clearly shows that there is no pterostigma. Furthermore, because Kukalová-Peck and Lawrence (1993) treat the pterostigma as a landmark for homologizing veins (p. 191), they have no criterion for determining whether the pterostigmas themselves are homologous; they simply assume homology.

Character 9: *A very long fork of MP* (Kukalová-Peck, 1991; synapomorphy).

Interpretation: Kukalová-Peck and Lawrence's drawing (fig. 69) of *Mengenilla* shows MP forked into MP_{1+2} (MA_1 of Kinzelbach) and MP_{3+4} (MA_2 of Kinzelbach). The states of this character are "fork not very long" (plesiomorphy) and "fork very long" (apomorphy).

Evaluation: The authors provide no criterion for distinguishing a "very long" fork from one which is "not very long." We have examined all the genera of the most basal Strepsiptera, the Mengenillidae (*Mengenilla, Eoxenos,* and a new genus from N. Africa [Kathirithamby, in prep.]). Contrary to the author's drawings, in all of these taxa MP is not forked (i.e., MA_1 and MA_2 are not joined basally, Fig. 8).

CRITIQUE OF PHYLOGENETIC METHODOLOGY

While the authors couch their terminology in cladistic parlance, their methodology is pseudo-cladistic and at discord with the theoretical basis of cladistics. The authors

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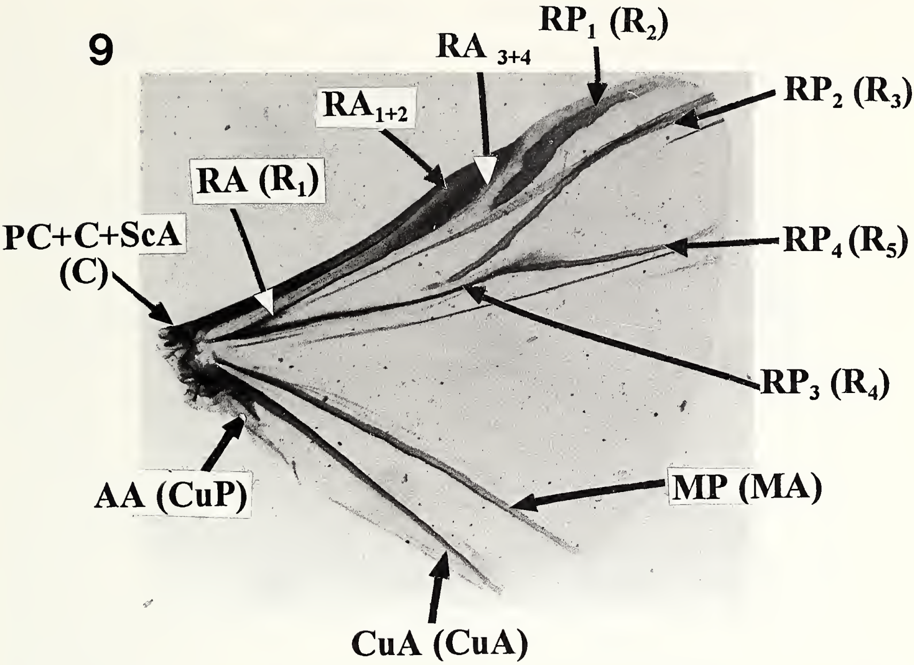

Fig. 9. Light microscopic photo of strepsipteran metathoracic wing. Coriophagus rieki Kinzelbach (Halictophagidae). Scale: X26.

do not follow cladistic principles in selecting characters, determining character polarity, appealing unduly to groundplans and evolutionary scenarios, neglecting a formal parsimony analysis prior to their conclusions, and using "shared autapomorphic trends" to support monophyly.

Rooting and polarity

The authors do not follow the application of character polarity in a cladistic context. Character polarity is assessed by outgroup comparison or ontogenetic study and is determined directly by where the root is placed in a branching network (Waltrous and Wheeler, 1981; Farris, 1982; see Nixon and Carpenter [1993] for an excellent discussion). Character states are scored for the ingroup and outgroup taxa, an unrooted network is generated, the ingroup is rooted to the outgroup, and the polarity of the characters are subsequently obtained by their optimization on the tree. There is no need—and indeed, no clear way—to establish whether a character is "primitive" or "derived" prior to cladistic analysis (Nixon and Carpenter, 1993). Neither is there any need for scenarios involving the direction a suite of characters must have evolved in order for the characters to be phylogenetically informative. The distinction between synapomorphy and plesiomorphy is meaningless in the absence of a rooted cladogram, and the assignment of polarity in the absence of a tree is specious.

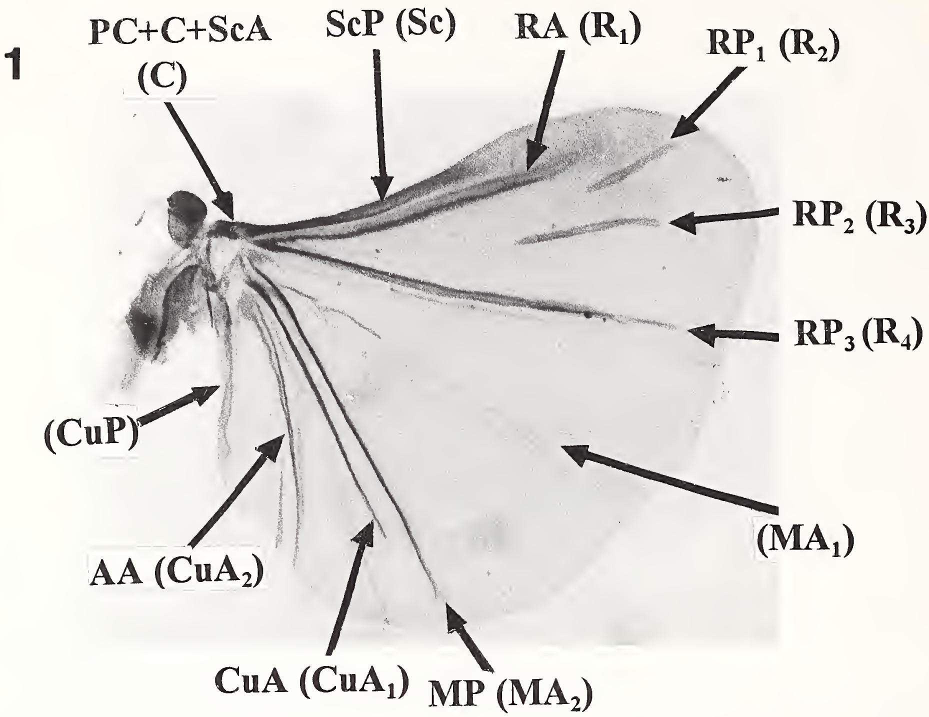

Fig. 10. Light microscopic photo of strepsipteran metathoracic wing. *Lychnocolax drysdalensis* Kathirithamby (Myrmecolacidae). Scale: X54.

The polarization of the venational characters presented by Kukalová-Peck and Lawrence is not based on any empirical evidence of character state distribution in ingroups and outgroups. Instead, the authors rely on comparisons to the "all-pterygote groundplan" and appeals to scenarios of directionality in the evolution of insect veins. How are these groundplans generated? "Venational groundplan is a *compilation of primitive features* [sic] assembled over many years by comparing the primitive representatives of *all* [sic] extinct and extant pterygote orders" (Kukalová-Peck and Lawrence, 1993: 194). The authors' designations of character polarities are simple statements of concordance with some preconceived notion of primitive wing venation; this is a far cry from polarization as it is commonly practiced in cladistic analysis.

Beyond the sheer subjectivity of this methodology, and the rather dubious claim that all extinct insect orders have left traces for these authors to include in their groundplan, we find a number of problems with this procedure. First of all, organisms are not compilations of distinct features found in different groups (if so, phylogenetics would be a meaningless pursuit). By the authors' own admission, there has never been an organism observed which possesses all of these putatively primitive wing features in combination. Then why should the combination of character states observed in extant (or extinct) taxa be polarized by comparing them with a combi-

nation of states which has never been observed in any taxon? How can unobserved states in a hypothetical taxon constitute evidence for polarization? Why should presumed data (which are not really data anyway) take precedence over observable data?

In the authors' explanation of the groundplan, they suggest that the groundplan represents the primitive states of characters as found in the most recent common ancestor of all the taxa used in the compilation. But how is this combination of presumed ancestral states obtained? It is clearly **not** obtained by the cladistic practice of optimizing characters on nodes of a cladogram. It is in fact quite possible that the combination of character states as proposed for the "all-pterygote" ancestor cannot co-occur once those states are optimized on a tree. Moreover, why would we expect the common ancestor of those taxa to have all the presumably primitive features of all the taxa used in the compilation? This would seem to suggest that all the taxa share only that ancestor in common rather than sharing a hierarchy of ancestry.

More critically, how do the authors know that these states are indeed primitive? This tautological conclusion stems from the procedure of using "primitive representatives" to infer "primitive features". How do we know these representatives are primitive? Simple, they have retained primitive features. How do we know they have retained primitive features? Because they are primitive taxa. But of course whether they are *a priori* considered primitive or not is moot for cladistic analysis. The real question should be how do the authors know, in the absence of a cladogram, that a given character is a synapomorphy? Once more, the authors are confronted with drawing conclusions of polarity without reference to a specific phylogeny.

This confusion over cladistic methodology is best summarized by the authors' statement that "it is also not possible [to use coleopteran venation in phylogeny] without determining the succession of veinal character states based on the all-pterygote groundplan" (p. 194). It is possible and, in fact, is routine to use venational characters for phylogenetic inference by scoring similar vein modifications in multiple taxa and appropriate outgroups without reference to a groundplan. A tree is reconstructed, a rooting selected, and then (if one wishes) the "succession of veinal character states" can be hypothesized by the optimization of these characters on the tree. It is not that we are specifically arguing that this groundplan is incorrect, we are only arguing that the groundplan has not been inferred correctly and that it should not be used as a means to polarize characters. The use of artificial amalgamations of presumed primitive characters as a basis for character polarization is without theoretical and empirical support and is far outside the realm of cladistic analysis.

Outgroups and analysis

We are concerned with the authors' apparent lack of adequate comparison of their putative synapomorphies with the appropriate outgroups. These characters were not explicitly scored for other holometabolous insect orders, nor were they specifically scored for the Paraneoptera which are the currently accepted outgroup to the Holometabola (Kristensen, 1991). Because the authors have presented us with only a two taxon statement, we have no way of knowing the level of generality of these characters. It appears that the authors assumed *a priori* that Strepsiptera and Coleoptera

are sister-groups, thereby forcing a coleopteran venational scheme upon Strepsiptera, and they then searched for characters which would validate this supposition.

The authors also did not provide a specific cladistic analysis of their character data in the Strepsiptera, Coleoptera, and outgroups. In the absence of this analysis, it is premature for the authors to make any claims regarding whether a character is a synapomorphy or not. Hence, even if the authors' putative synapomorphies could be defined as discrete characters, they have yet to demonstrate in an analysis that any of these shared similarities are unique to Strepsiptera and Coleoptera and are synapomorphic rather than symplesiomorphic. The conclusion that a particular character is a synapomorphy, with no explicit cladistic analysis to determine polarity, smacks more of authoritarianism than science.

Evolutionary scenarios

The success of cladistics has lain in part with its ability to separate pattern and process: phylogenies represent the pattern from which evolutionary processes are inferred. Thus cladistics attempts to tease apart the evidence for phylogeny from any specific model of evolution (Eldredge and Cracraft, 1980).

The authors have unduly mixed pattern with process into their phylogenetic conclusions by proceeding under the assumption that veins evolve according to a known set of rules and that character designation and polarity determination can be confidently based upon these rules. These rules include the "two major venational principles": (1) the loss of primary veins and their main branches is irreversible, and (2) the fusion of two primary veins near the wing base is irreversible. According to the authors, the veracity of these principles is established by the fact that entomologists have been studying veins for over 100 years and that "through this long experience, the sequences of character change have become well established" (Kukalová-Peck and Lawrence, 1993: 186). We are not so confident. It is not clear to us why the authors consider these principles well established as they have never been empirically tested on a phylogeny created independent of these principles. As no one (to our knowledge) has used parsimony to optimize the fusion and loss of primary veins on a ordinal phylogeny for the insects and demonstrated evolution according to Dollo parsimony, we would argue that there yet remains no specific test for the veracity of these principles.

Our argument is not that these principles are wrong, only that the authors have placed undue weight on their veracity in drawing phylogenetic conclusions. These principles may be true. But because the authors have needlessly based their phylogenetic conclusions on these assumptions, they cannot specifically test these principles using their phylogeny.

Autapomorphic trends

The authors appear confused as to what types of characters constitute evidence for phylogenetic inference—is it synapomorphy, symplesiomorphy (character 4), or "shared autapomorphic trends" (characters 3, 5, 6, & 7)? The use of the term "shared autapomorphic trend" is not derived from cladistic literature. How is a shared autapomorphic trend indicative of phylogeny? In what sense is a shared autapomorphic trend a derived homologous feature in a group of organisms? If a trend

is shared, what is the level of generality of this sharing? How does sharing a trend translate to a unique, derived evolutionary event in the common lineage of these presumed sister-taxa? How does one in practice distinguish a shared autapomorphic trend from a synapomorphy?

The author's claim that certain characters constitute autapomorphic trends seems to indicate they think them weaker than a synapomorphy, but still phylogenetically informative. This may explain why characters 6 and 7 were changed (without explanation) from synapomorphies in the 1991 paper to shared autapomorphic trends in the 1993 paper. The notion that shared autapomorphic trends are phylogenetically informative, however, is dangerous in that it allows **any** character distribution to be interpreted as synapomorphic evidence. The concept of shared autapomorphic trends as indicative of phylogeny is foreign to cladistic theory.

CONCLUSIONS

Venational homologies in the highly modified hind wings of Coleoptera have long eluded entomologists. The attempt by Kukalová-Peck and Lawrence is a commendable effort, but we have some basic criticisms of their character interpretations and phylogenetic methodology.

As detailed above, we are concerned with the author's misinterpretation of strepsipteran morphology. The characters they have proposed are in many cases unobservable, continuous, or of questionable homology. We have further demonstrated discrepancy between the veins the authors have drawn on the three strepsipteran species they examined, and those which we observe in the specimens. Kukalová-Peck (1991) concludes that "quite clearly, Strepsiptera venation can be derived only from a common ancestor with Coleoptera or from a coleopteroid stem group" (p. 178). We argue that their current analysis does not support this conclusion.

By failing to score these characters in other holometabolous insect orders and neglecting to score any other venational character which Strepsiptera (or Coleoptera) may share with any other insect order, Kukalová-Peck and Lawrence have biased their results to support their conclusions. We feel that the authors should be more concerned with scoring putatively homologous venational features across multiple ingroup and outgroup taxa, creating a character matrix with these and other characters for a formal cladistic analysis, and allow parsimony to arbitrate among possible phylogenetic conclusions and to decide which characters are synapomorphies. The hypothetical ancestral states can then be derived by optimizing the venational states on the tree and any scenario for trends in venational evolution could likewise be derived from the tree. The characters lead to the presumed ancestral states and not the presumed ancestral states to the characters.

We find no evidence from the hind wing venation to support a sister-group relationship between Strepsiptera and Coleoptera.

ACKNOWLEDGMENTS

We thank J. Carpenter, J. Liebherr, W. Wheeler, and D. Grimaldi for helpful suggestions. MFW was supported in part by a NSF dissertation improvement grant. JK wishes to thank the Leverhulme Trust for the Research Fellowship and the Linnean Society for the taxonomic publications grant.

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CLADISTIC ANALYSIS OF THE *ULMERITUS-ULMERITOIDES* GROUP (EPHEMEROPTERA, LEPTOPHLEBIIDAE), WITH DESCRIPTIONS OF FIVE NEW SPECIES OF *ULMERITOIDES*

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Abstract.—A cladistic analysis of the species of the genera *Ulmeritus* and *Ulmeritoides* is performed. Five new species of *Ulmeritoides* are described: *U. fidalgoi* n. sp. from male and female imagos and *U. misionensis* n. sp. from male and female imagos and nymphs from Argentina, *U. spinulipenis* n. sp. from male imagos from Uruguay, and *U. guanacaste* n. sp. and *U. tifferae* n. sp. from male imagos and nymphs collected in Costa Rica. *U. flavopedes* is redescribed; *U. uruguayensis* (=*U. adustus* n. syn.), *U. luteotinctus* and *U. patagiatus* are discussed. The generic diagnosis of *Ulmeritoides* is modified to include all known species. Further evidence from the cladistic analysis supports the synonymy of *Pseudulmeritus* with *Ulmeritoides*, the monophyly of *Ulmeritus* and *Ulmeritoides*, and their status as sister groups.

The *Ulmeritus–Ulmeritoides* group is a very distinctive complex among the Leptophlebiidae. For a long time it was known only from a few species collected from NE Brazil, Uruguay and NW Argentina, with a single record from Suriname. New collections are now available to clarify the taxonomy and phylogeny of the group.

Ulmeritoides was established as a subgenus of *Ulmeritus* by Traver (1959) for *Ulmeritus* (*Ulmeritoides*) *uruguayensis* Traver, known from imagos of both sexes, and *U.* (*Ulmeritoides*) *luteotinctus* Traver, known only from female imagos. In 1960, Thew described *U.* (*Ulmeritoides*) *adustus* from imagos of both sexes and *Ulmeritus patagiatus* from subimagos, not assigning the last species to any subgenus. At that time, the only known nymph of *Ulmeritus* was that of *U. carbonelli* Traver.

In 1987 Savage suggested that *Ulmeritus* might be related to the *Hermanella* complex, but Flowers and Domínguez (1991) proposed a preliminary cladogram in which *Ulmeritus* and *Ulmeritoides* were more closely related to *Atopophlebia* and *Meridialaris.* A new species of the subgenus *Ulmeritoides* was reared for the first time and, based on the characteristics of both sexes, the subgenus was raised to full generic status (Domínguez, 1991).

In this paper I describe five new species of *Ulmeritoides* and discuss the species *U. uruguayensis, U. luteotinctus* and *U. patagiatus.* The species *U. adustus* is synonymized with *U. uruguayensis,* and *U. flavopedes* (Spieth) is redescribed. The generic diagnosis of *Ulmeritoides* is modified to include all known species and a phylogeny for the *Ulmeritus-Ulmeritoides* complex is reconstructed and discussed.

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MATERIALS AND METHODS

Material from the following institutions was used: Universidad de la República, Montevideo, Uruguay (URU); Florida Agricultural and Mechanical University, Tallahassee, Florida, USA (FAMU), National Museum of Natural History, Smithsonian Institution, Washington, D.C., USA (NMNH), American Museum of Natural History, New York, USA (AMNH), Illinois Natural History Survey, Illinois, USA (INHS), Instituto Nacional de Biodiversidad, Costa Rica (INBio) and Instituto–Fundación Miguel Lillo, Tucumán, Argentina (IFML).

The phylogenetic relationships of the group were reconstructed with the aid of the Hennig86 (Farris, 1988) and CLADOS (Nixon, 1992) programs.

Genus **Ulmeritoides**

Ulmeritus (*Ulmeritoides*) Traver, 1959:8; Thew, 1960:125.
Ulmeritus (*Pseudulmeritus*) Traver, 1959:8.
Ulmeritoides; Domínguez 1991:160; Flowers and Domínguez, 1991:52.

Type species: *Ulmeritoides uruguayensis* (Traver), Original designation, as type species of *Ulmeritus* (*Ulmeritoides*).
Species included: *U. luteotinctus* (Traver), *U. patagiatus* (Thew), *U. uruguayensis* (Traver), *U. flavopedes* (Spieth), *U. spinulipenis* new species, *U. fidalgoi* new species, *U. misionensis* new species, *U. tifferae* new species, *U. guanacaste* new species.
Distribution: From Costa Rica (11°N) to NE Argentina (27°S).
Discussion: This genus was characterized recently by Domínguez (1991) for both stages and sexes. With new material available, some modifications in the generic diagnosis are needed. 1) The development of the median denticle on the anteromedian emargination of the labrum is not a constant character for the genus, but differs among species; 2) the generic description of the male genitalia should read: "Penis divided from the base, apex of penis lobes rounded to rather straight, with spines, small projections or with lateral groove"; 3) the posterolateral projections on abdominal segments VIII-IX (Fig. 2A) are of unusually large size for the family, presenting lateral spines. This character is also present in *Ulmeritus* species (Fig. 2B).

Material certainly belonging to this genus, but not assignable to any described species is given here to make distributional data available for further investigations: *Ulmeritoides* spp. (2 species): BRAZIL, Pará, Rio Xingú, Camp (52°22′W, 3°39′S) ca. 60 km S. Altamira. 8-16/X/1986. P. Spangler and O. S. Flint, Jr., Igarapé-Jabutí (2 female imagos, 2 male subimagos) (NMNH); *Ulmeritoides* sp. GUYANA: Mazaruni-Potaro District, Takutu Mountains (16°15′N, 59°5′W), 18/XII/1983, P. J. Spangler, W. E. Steiner and M. L. Levine. Earthwatch Expedition (1 nymph) (NMNH); *Ulmeritoides* sp. PARAGUAY: Paraguari, Depto Ybycui (25 km SE) in Ybycui National Park, 12-24/IV/1980, P. J. Spangler *et al.* (12 nymphs) (NMNH); *Ulmeritoides* sp. VENEZUELA: T. F. Amazonas, Puerto Ayacucho (40 km S) Tobogán, 19/II/86. P. J. Spangler, Col. # 1. (1 nymph) (NMNH); *Ulmeritoides* sp. GUATEMALA: 20 mi SW Puerto Barrios, 16/VIII/1965. P. J. Spangler (1 nymph) (NMNH); *Ulmeritoides* sp. FRENCH GUIANA: Sinnamary River, Saut Dalles Fleuve, 15/16/VI/92, V. Horeau (10 male subimagos, 3 female imagos, 2 female subimagos, 9 nymphs) (FAMU); Sinnamary River, Saut Maïpouri, 24-26/V/93, V. Horeau (1 female imago, 1 male subimago) (FAMU).

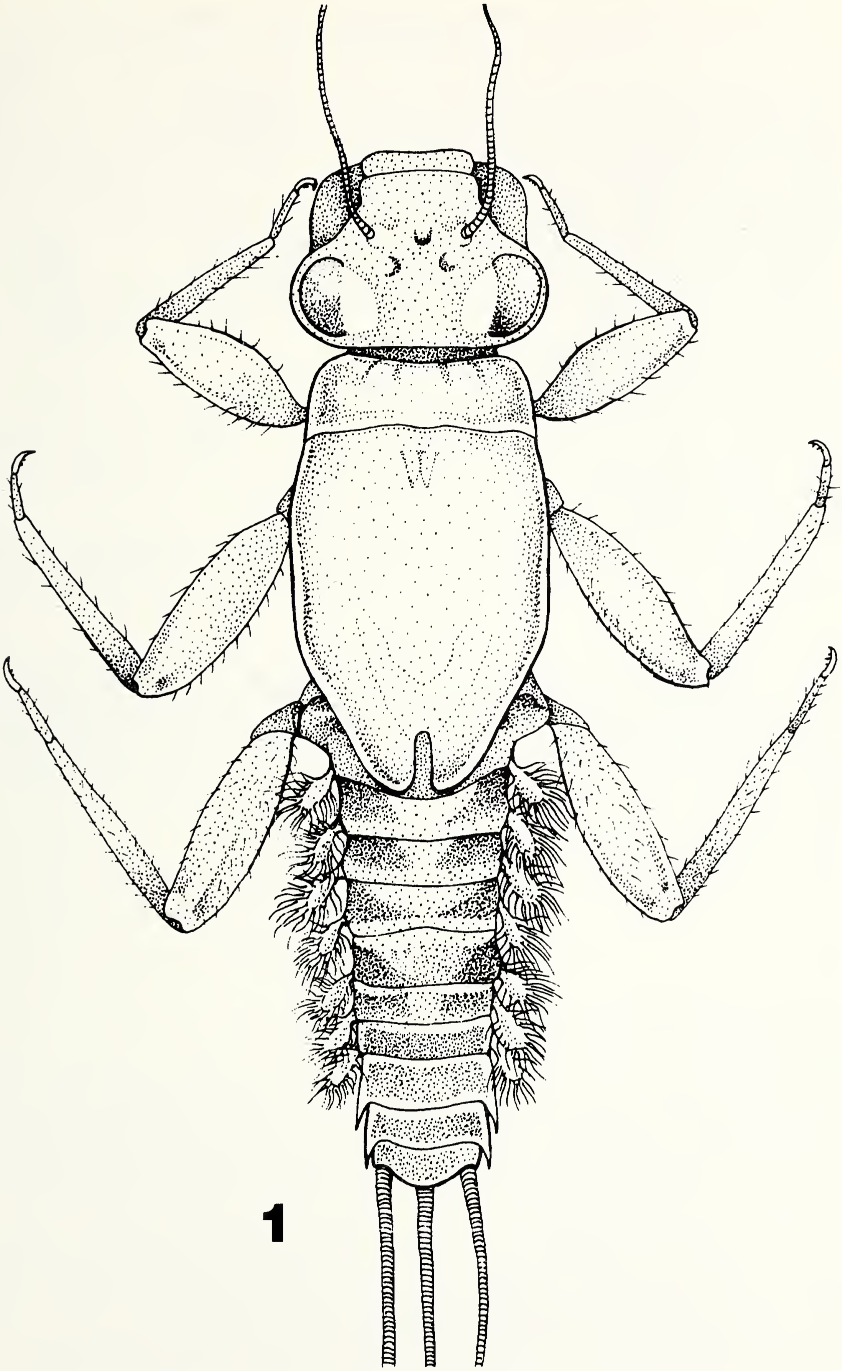

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Fig. 1. *Ulmeritoides misionensis* nymph, dorsal view.

Key to the species of the genus *Ulmeritoides*
Male imagos

1. Forewings with costal and subcostal areas tinged with brown (Figs. 8A, 9A) 2
   Forewings with costal and subcostal areas hyaline (Figs. 4A, 12A) 4
2. Apex of penis lobes straight, ending in an acute, apical projection (Fig. 8F, G); abdominal color pattern as in fig. 8D, E .... *U. misionensis* n. sp.
   Apex of penis lobes more or less rounded, abdominal color pattern not as above 3
3. Longitudinal veins of forewings brownish, cross veins blackish; penis lobes with a shallow small prominence on outer margin, near apex (Fig. 9F, G) .... *U. tifferae* n. sp.
   Veins C, Sc and R1 of forewings brown, remaining longitudinal veins yellowish, cross veins whitish; penis lobes with a small spine on ventral surface of outer corner (Fig. 7B, C) .... *U. fidalgoi* n. sp.
4. Apex of penis lobes rounded (Figs. 4F, 12G) 5
   Apex of penis lobes not rounded (Figs. 5A, 6D) 6
5. Veins C, Sc and R1 of forewings yellowish; each penis lobe with a lateral groove (Fig. 4E, F) .... *U. flavopedes* (Traver)
   Veins C, Sc and R1 of forewings yellowish, blackish the stigmatic area; each penis lobe with a small prominence on outer margin (Fig. 12G) .... *U. guanacaste* n. sp.
6. Penis lobes with apical margin ending in an acute projection (Fig. 5A) .... *U. uruguayensis* (Traver)
   Penis lobes with several small spines on apical margin (Fig. 6D) . . *U. spinulipenis* n. sp.

Nymphs

1. Tibiae I with two black bands; medial denticle on anteromedian emargination of labrum much larger than the other four (Fig. 8H) .... *U. misionensis* n. sp.
   Tibiae I almost completely washed with black, except base and apex lighter; medial denticle on anteromedian emargination of labrum subequal in size to other denticles (Fig. 10A, B) 2
2. Dorsum of femora II and III with numerous short, acute spines; femora II with a median black spot; abdominal color pattern as in Figure 9D .... *U. tifferae* n. sp.
   Dorsum of femora II and III with a few short, blunt spines; femora II without a median black spot; abdominal color pattern as in Figure 12D .... *U. guanacaste* n. sp.

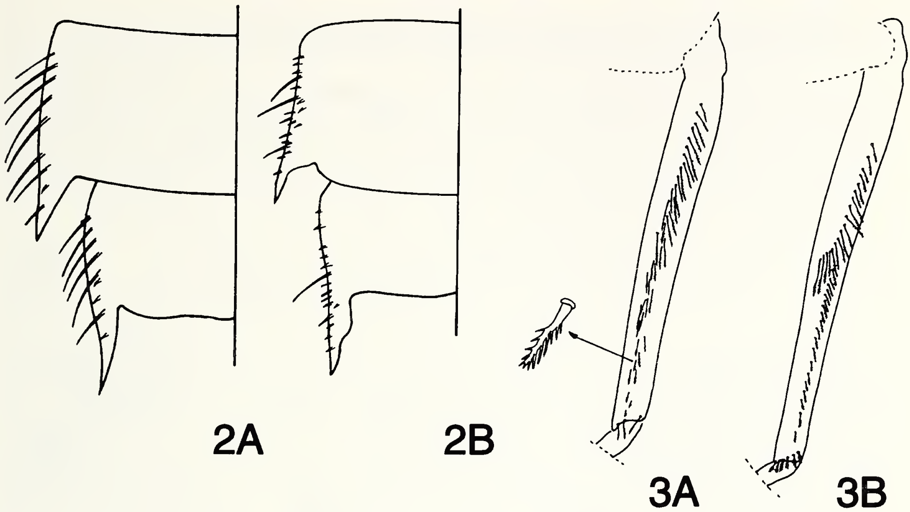
Ulmeritoides luteotinctus (Traver)

Ulmeritus (*Ulmeritoides*) luteotinctus Traver, 1959:11.
Ulmeritoides luteotinctus, Domínguez, 1991:162.

Discussion: Traver (1959) described this species based on female imagos and subimagos of both sexes. As the original description is adequate, I will not redescribe it. However, due to its different wing coloration, it is possible that the male subimagos do not belong in the same species. Within the paratypes, there are three that resemble the color pattern of *U. uruguayensis.*

U. luteotinctus can be separated from the other species of the genus by the following combination of characters: 1) forewings hyaline, veins orange-brown, lighter toward posterior margin; 2) abdominal terga and sterna yellowish, slightly tinged with brownish, posterior margin of each segment narrowly darker.

Material: Holotype female imago: URUGUAY, Artigas, Arroyo La Invernada, 21/II/54, C. S. Carbonell (URU). Paratypes: 7 female imagos, Timbauba, Arroyo Tres



Figs. 2–3. Nymphs. 2, posterolateral projections on abdominal segments VIII–IX: A, *Ulmeritoides tifferae*; B, *Ulmeritus carbonelli*. 3, Detail of tibia III: A, *Ulmeritoides tifferae*; B, *Ulmeritus carbonelli.*

Cruces, 21/II/54, C. S. Carbonell (URU); idem, 1 female imago, 20/II/55; 1 female imago, Sepulturas, Picada del Negro Muerto, Rio Cuareim, 15/XII/57, C. S. Carbonell (URU). Also studied: 2 female imagos, 2 male subimagos, 1 female subimago, Cerro Largo, Arroyo Quebracho (curso superior), 4-8/III/59, C. S. Carbonell (URU); 1 male subimago, Tacuarembó, Tacuarembó Chico, 20/I/60, C. S. Carbonell (URU).

Ulmeritoides flavopedes (Spieth)

Thraulodes flavopedes Spieth, 1943:11.
Atalophlebioides flavopedes, Traver, 1946:426.
Ulmeritus (*Pseudulmeritus*) *flavopedes,* Traver, 1959:8.
Ulmeritoides flavopedes, Domínguez, 1991:162.

Holotype male imago (pinned, one pair of wings and genitalia mounted on slides). Length: body, 6.6–6.7 mm; forewings, 8.0–8.1 mm; hind wings, 1.5–1.6 mm. General coloration bright orange-brown. Wings hyaline. *Head* light brown. Upper portion of eyes orange-brown, lower portion blackish. Antennae: scape and pedicel brownish, flagellum lighter. *Thorax:* pronotum light brown, with posterior margins black; mesonotum, pleura and sterna bright orange, carinae darker; metanotum light orange, weakly washed with black. *Wings* (Fig. 4A, C): membrane of both wings hyaline, wing bases brown. Veins C, Sc and R1 yellowish, remainder hyaline. *Legs:* Leg I brown, except apex of tibiae and tarsi I yellow, tarsomeres II–V grayish; tarsal claws orange. Legs II–III yellowish except coxae, trochanters, base and median band on femora brownish. *Abdomen* (Fig. 4D): terga orange-brown with posterior margins blackish. Sterna grayish-orange. *Genitalia* (Fig. 4E, F): Apex of penis lobes rounded, each with a lateral groove (colors faded).

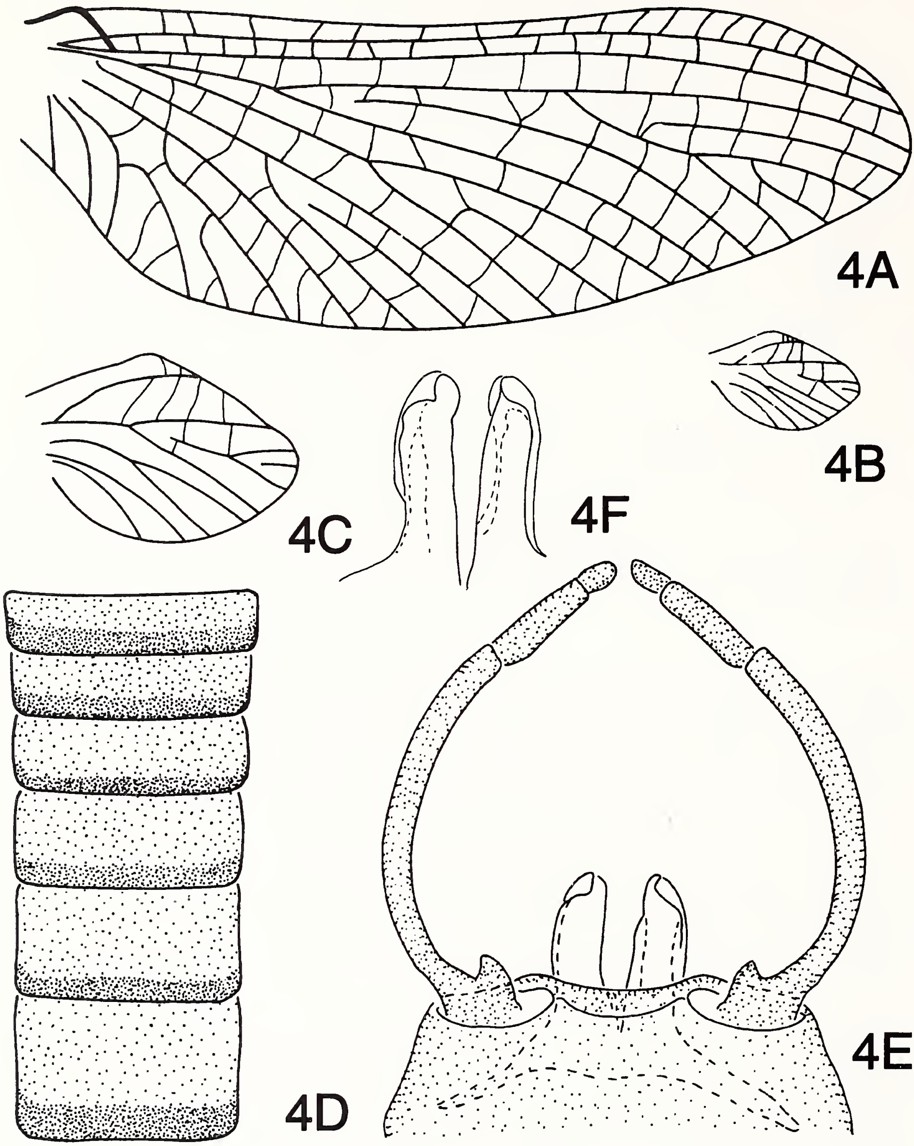


Fig. 4. *Ulmeritoides flavopedes.* Male imago. A, forewing; B, hind wing; C, hind wing enlarged; D, abdominal terga II–VII; E, genitalia (ventral view); F, penis lobes (ventral view, enlarged).

Material: Holotype male imago: SURINAM, Moengo, 12/IV/1939, D. C. Geijskes col (AMNH). Paratype: SURINAME, Litani river, Feti Creek, 17/VII/1939, D. C. Geijskes (AMNH).
Discussion: Traver (1959) established the subgenus *Pseudulmeritus* for this single species. When I elevated *Ulmeritoides* to the generic level (Domínguez, 1991) I tentatively included *U. flavopedes.* Based on the phylogenetic relationships of *Ulmeritoides* species, this placement is confirmed (see discussion under phylogeny).

Ulmeritoides patagiatus (Thew)

Ulmeritus patagiatus Thew, 1960:128.
Ulmeritoides patagiatus, Domínguez, 1991:162.

Discussion: Thew (1960) described this species based on subimagos of both sexes, not assigning it to any subgenus. After studying the type material it is clear that this species belongs in *Ulmeritoides* (Domínguez, 1991); however, until imagos of this species are obtained it cannot be redescribed or synonymized.
Material: Holotype male imago and Allotype female imago: BRAZIL, Santa Catarina, Nova Teutonia, F. Plaumann, IX/1956 (INHS).

Ulmeritoides uruguayensis (Traver)

Ulmeritus (*Ulmeritoides*) *uruguayensis* Traver, 1959:8.
Ulmeritoides uruguayensis, Domínguez, 1991:162.
Ulmeritus (*Ulmeritoides*) *adustus* Thew, 1960:126. **NEW SYNONYMY.**

Discussion: This species was adequately described by Traver (1959). I include an illustration of the penis, because they can be of use for the identification of this species. The abdominal color pattern and the wings are very similar to *Ulmeritoides spinulipenis.*

Ulmeritus (*Ulmeritoides*) *adustus* is a synonym of *U. uruguayensis.* In his original description, Thew (1960) indicated as diagnostic characters for this species two small spines on the penis lobes, and the abdominal and leg coloration. I had the opportunity to study the types and I did not find any difference between the genitalia of *U. adustus* and *U. uruguayensis.* Also, the coloration fits within the intraspecific variation of *U. uruguayensis.*

Ulmeritoides uruguayensis can be separated from the other species of the genus by the following combination of characters: 1) forewings hyaline, brown spot at base; 2) abdominal color pattern similar to that in Figure 6B; 3) 7–8 cross veins basal to bulla in forewings; 4) penis as in Figure 5A.
Material: Holotype male imago: URUGUAY, Artigas, Arroyo de la Invernada, C. S. Carbonell, 21/II/54 (URU). Paratypes: 2 male imagos, 20 female imagos, 30 male subimagos, 15 female subimagos (idem Holotype); 1 male imago, 15 female imagos, 3 male subimagos, 4 female subimagos, Sepulturas, Rio Cuareim, C. S. Carbonell, 13/I/52 (URU). Other material: 40 male subimagos, 5 female subimagos, Cerro Largo, Arroyo Quebracho (Curso Superior), C. S. Carbonell, 4-8/III/59 (URU); 1 female subimago, Tacuarembó, Valle Edén, F. Achaval, IV/80 (URU). Also studied: *U.* (*U.*) *adustus,* Holotype and Allotype: BRAZIL, Santa Catarina, Nova Teutonia, F. Plaumann, II/57 (INHS).

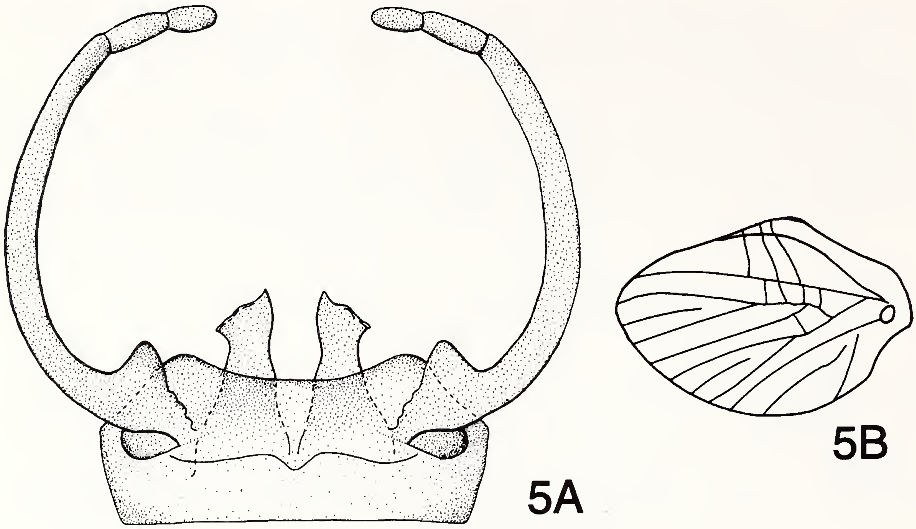


Fig. 5. *Ulmeritoides uruguayensis*. Male imago. A, genitalia (ventral view); B, hind wing.

Ulmeritoides spinulipenis, new species

Holotype male imago (in alcohol). Length: body, 7.0–7.3 mm; forewings, 7.2–7.5 mm; hind wings, 1.4–1.5 mm. General coloration orange-brown, abdomen lighter. *Head* whitish, diffusely washed with black. Upper portion of eyes reddish-brown, lower portion blackish. Ocelli white, ringed with black at base. Antennae light orange, flagellum lighter. *Thorax:* pronotum light orange-brown with lateral and posterior margins and paramedian areas grayish, median area blackish; mesonotum bright orange-brown, carinae darker; metanotum grayish-brown; pleura brownish, with white spots close to wing bases; sterna light-brown, darker in median area. *Wings* (Fig. 6A): membrane of forewings hyaline, light brown at base, stigmatic area translucent, three small spots, one on bulla and others two in line with it on the next two veins; veins whitish, except apical ½ of C, Sc and R1 brownish; 9–10 cross veins basal to bulla. Membrane of hind wings hyaline (Fig. 6A), brown spot at base; veins C and Sc yellowish, remaining veins whitish. *Legs:* Leg I orange-brown, washed with black on coxae and trochanters and on external side of femora; narrow black band located at ⅔ apical of femora, tibiae blackish except basal part orange-brown and distal part whitish; tarsi yellowish; legs II and III yellowish, washed with black on coxae and trochanters; two narrow black bands on femora, one on apical ⅔ and the other on apex. *Abdomen* (Fig. 6B): terga brownish-yellow, terga I-III almost completely washed with black, remaining segments with black markings enclosing a lighter central area, tergum X yellowish; sterna yellowish, diffusely washed with black. *Genitalia* (Fig. 6C, D): bright orange-brown, forceps orangish, paler toward apex. Penis whitish with small spines as in Figure 6D. Caudal filaments whitish, with black rings at each intersegmental joint, alternating one wide and one narrow.

Female and nymph: Unknown.

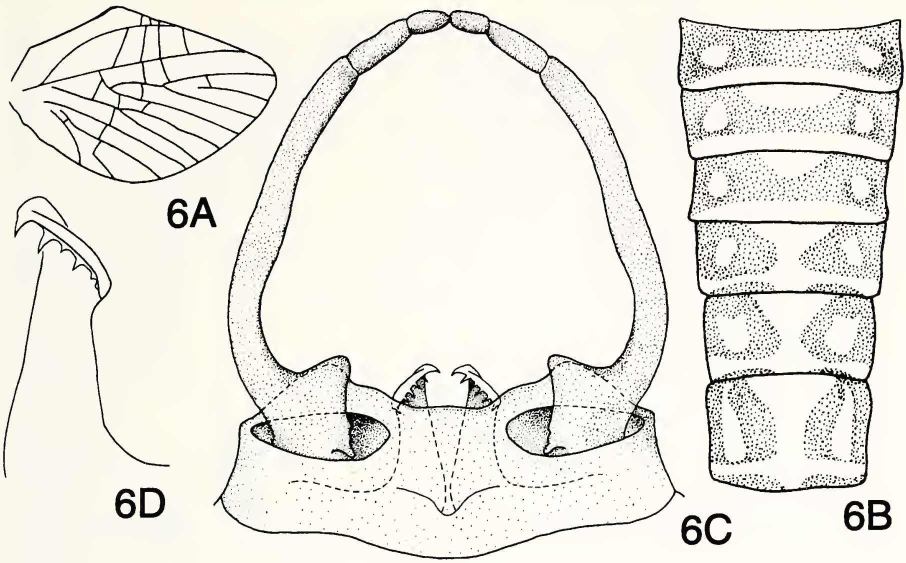


Fig. 6. *Ulmeritoides spinulipenis*. Male imago. A, hind wing; B, abdominal terga II–VII; C, genitalia (ventral view); D, penis lobe (ventral view, enlarged).

Material: Holotype male imago: URUGUAY, Tacuarembó, Tacuarembó chico, C. S. Carbonell, 20/I/1960 (URU). Paratypes: 2 male imagos (idem holotype) (IFML). Other material: 2 male subimagos, Paysandú, Santa Rita, C. S. Carbonell et all. 20/I/62 (URU); 1 male subimago, ARGENTINA, Misiones, Puerto Libertad, O. S. Flint, Jr., 24/XI/73 (USNM).
Etymology: L. spinula, meaning small spine, and L. penis, penis.
Discussion: *Ulmeritoides spinulipenis* can be separated from the other species of the genus by the following combination of characters: 1) forewings hyaline, with three small spots, one on the bulla and the other two in line with it on the next two veins; 2) abdominal color pattern as in Figure 6B; 3) 9–10 cross vein basal to bulla in forewings; 4) penis lobes with small spines as in Figure 6D.
Biology: Unknown.

Ulmeritoides fidalgoi, new species

Holotype male imago (in alcohol, genitalia on slide). Length: body, 6.5–7.2 mm; forewings, 8.0–8.5 mm; hind wings, 1.6–1.9 mm. General coloration: orange-brown, abdomen washed with black. *Head:* whitish, with anterior margin and lines between ocelli black. Upper portion of eyes orange-brown, lower portion blackish. Ocelli white, base black. Antennae: scape and pedicel orange-brown [flagellum broken off and lost]. *Thorax:* pronotum light-orange-brown, with lateral margins and median and paramedian areas blackish; mesonotum light yellow-brown, margins and carinae darker; metanotum light brown, washed with black; pleura orange-brown, with margins of sclerites washed with black; sterna bright orange-brown, washed with black

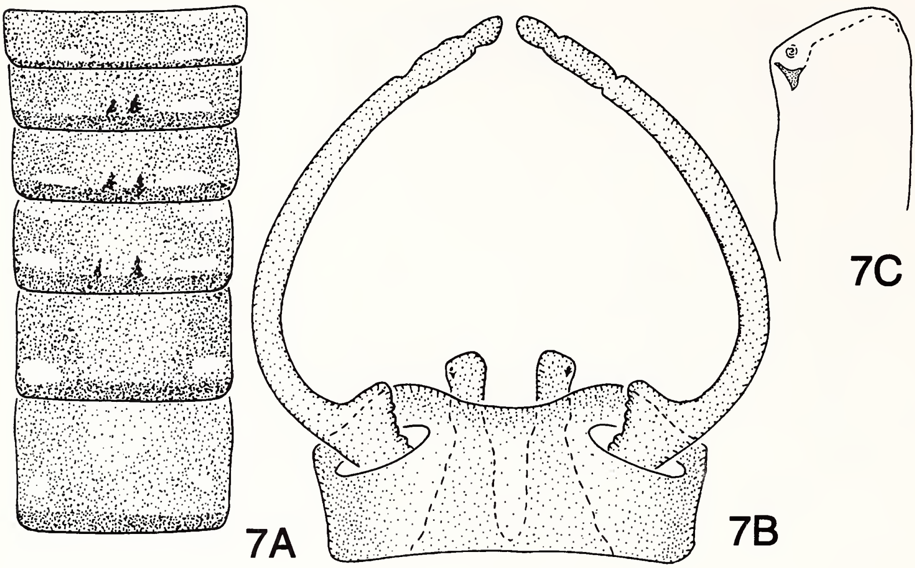


Fig. 7. *Ulmeritoides fidalgoi.* Male imago. A, abdominal terga II–VII; B, genitalia (ventral view); C, penis lobe (ventral view, enlarged).

in central area. *Wings:* membrane of forewings hyaline, costal and subcostal areas brown, paler toward apex, wing base brown. Veins C, Sc and R1 and cross-veins between them brownish; remaining longitudinal veins yellowish, cross veins whitish; 8–10 cross veins basal to bulla. Membrane of hind wings hyaline, brown spot at base; longitudinal and cross veins in costal area light brown, darker at base, remaining veins yellowish, lighter toward hind margin. *Legs:* coxae and trochanters orange-brown; femora light brown, femora I and II with medial and apical black spots; femora III with basal half, median band and apex blackish; tibiae yellowish, tarsi I–IV yellowish washed with gray, tarsi V and claws grayish-black. *Abdomen* (Fig. 7A): terga brown-orange, with black markings as in Figure 7A; markings darker in the first segments, paler toward the last ones; sterna orange-yellowish, washed with brown. *Genitalia* (Fig. 7B, C): subgenital plate and base of forceps light brown, remainder of forceps and penis yellowish. Each penis lobe with a small spine close to the outer corner (Fig. 7C). [Caudal filaments broken off and lost].

Allotype female imago (In alcohol). Length: body, 7.3–7.8 mm; forewings, 10.5–11.0 mm; hind wings, 1.9–2.2 mm. Similar to holotype except as follows: head light yellow, posterior margin blackish; eyes black; pronotum yellowish; mesonotum bright yellow; abdomen light grayish-brown, pattern paler.

Nymph: Unknown.

Material: Holotype male imago: ARGENTINA, Misiones, Bompland (Camping), Arroyo Martires, 26/XI/86, E. Domínguez col. (IFML); Allotype female imago, same data as holotype. Paratypes: 2 male imagos, 10 female imagos, 1 male subimago, same data as holotype; 2 female imagos, 1 male subimago, same data as holotype, except collected 15/II/85; 1 female subimago: Misiones, Arroyo Pepiri Mini (De-

sembocadura Rio Uruguay) 1/XII/86, E. Domínguez col. All material deposited in IFML, except 10 female imagos, 5 in (FAMU) and 5 in (NMNH).
Etymology: I name this species after my friend, the chalcidologist A. A. P. Fidalgo, with whom I was traveling when I collected this species.
Variation: In some females the mesonotal and abdominal color pattern is much paler than in the allotype.
Discussion: *Ulmeritoides fidalgoi* can be separated from the other species of the genus by the following combination of characters: 1) forewings hyaline, with costal and subcostal areas tinged with brown; 2) abdominal color pattern similar to the one in Figure 7A; 3) 8–11 cross veins basal to bulla of forewings; 4) penis as in Fig. 7B, C.
Biology: Unknown.

Ulmeritoides misionensis, new species

Ulmeritoides sp. Domínguez, 1991:166, figures. 18–29.

Holotype male imago (in alcohol, one pair of wings and genitalia on slides.) Length: body, 7.9–8.2 mm; forewings, 9.2–9.6 mm; hind wings, 1.8–2.0 mm. General coloration yellow-brown, abdomen washed with black. *Head:* light yellow, with median line and anterior margins washed with black. Upper portion of eyes light-brown, lower portion blackish. Ocelli white, black basally. Antennae: scape and pedicel orange-brown, flagellum yellowish, washed with black. *Thorax:* pronotum light brown with lateral, posterolateral and medial and paramedian areas blackish; mesonotum light yellow-brown, margins and carinae darker; metanotum light brown, washed with black; pleura yellow-brown, washed heavily with black; pro- and metasternum light brown, heavily washed with black, mesosternum yellowish, tinged with black in median area. *Wings* (Fig. 8A, C): membrane of forewings (Fig. 8A) hyaline, costal and subcostal areas light brown, stigmatic area much lighter, wing base light brown. Veins C, Sc and R1 and cross veins between them brownish; remaining veins whitish; 10 cross veins basal to bulla. Membrane of hind wings hyaline, brown spot at base (Fig. 8B, C); basal portion of vein Sc brownish, remaining veins whitish. *Legs:* coxae and trochanters light brown, heavily washed with black; femora I light brown with a black spot at mid-length and washed with black in basal half of apex; tibiae I light brown with a subbasal and a subapical black band; femora II yellowish with a black spot a little apically of median area; femora III yellowish with a black mark in median area and washed with black in basal 1/2 and apex; tibiae II and III yellowish-white; tarsi of all legs light yellow washed with gray; claws grayish-black. *Abdomen* (Fig. 8D, E): terga yellow-brown, with black markings covering posterolateral angles, lateral margins and delimiting a circular area lighter, as in Figure 8D; sterna light brown, heavily washed with brown on the anterior segments, lighter posteriorly. *Genitalia* (Fig. 8F, G): yellowish-brown, washed with black mainly in subgenital plate and apical 4/5 of forceps segment I. Apex of penis lobes straight, ending in an acute apical projection (Fig. 8G). Caudal filaments whitish, with black rings at each intersegmental joint, alternating one wide and one narrow.
Female subimago (in alcohol). Length: body, 7.0–8.0 mm; forewings, 11.0–11.5 mm; hind wings, 2.0–2.2 mm. Coloration as in male imago, except: head yellowish-white, posterior margin blackish; wing membrane translucent, tinged with yellowish-brown,

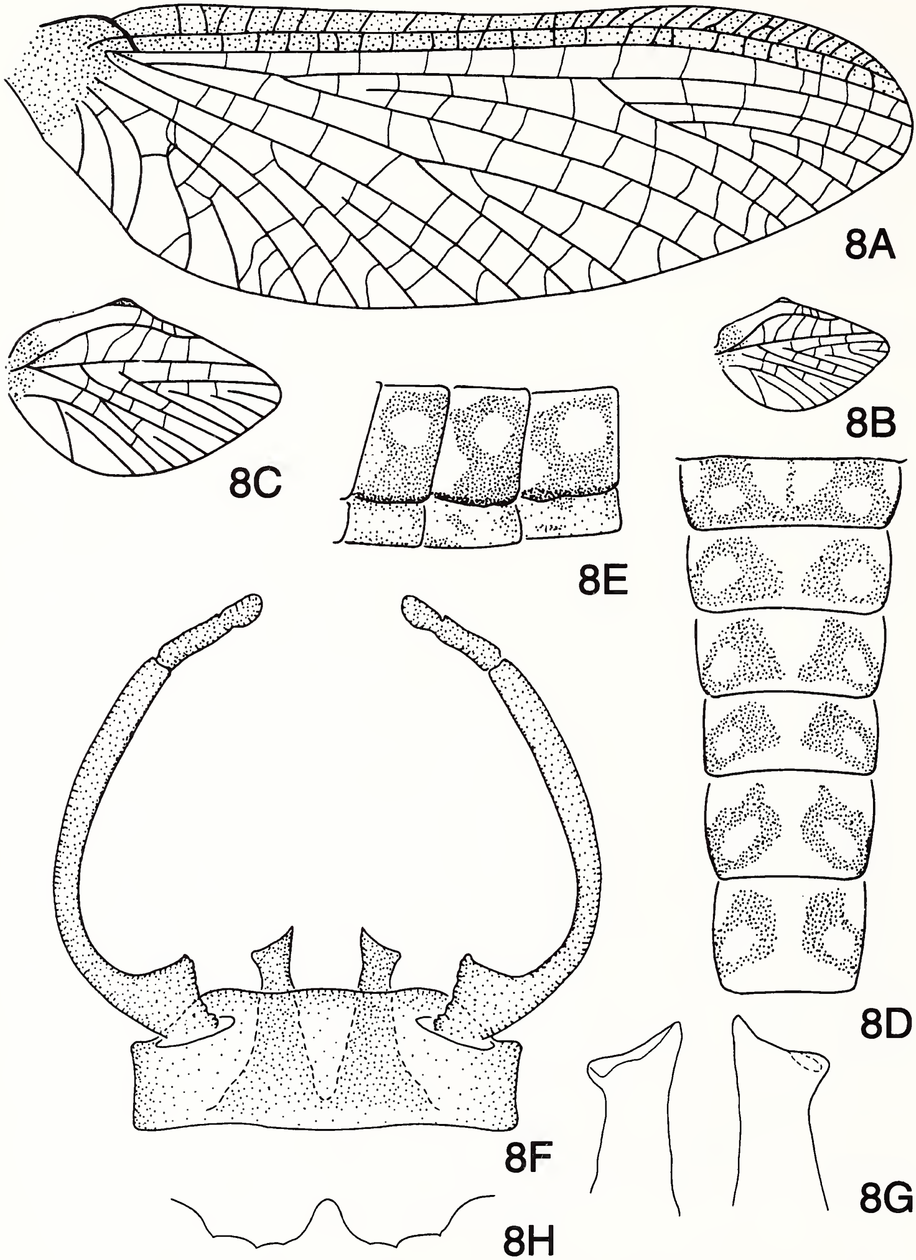


Fig. 8. *Ulmeritoides misionensis.* Male imago (A–G), Nymph (H). A, forewing; B, hind wing; C, hind wing enlarged; D, abdominal terga II–VII; E, abdominal segments V–VII, lateral view; F, genitalia (ventral view); G, penis lobes (ventral view, enlarged); H, detail of anteromedian emargination of labrum.

except costal and subcostal areas brownish; abdominal markings less marked than in male imago.

Mature nymph (in alcohol) (Fig. 1). Body length, 7.0–8.8 mm. General coloration: bright orange-brown with black markings. *Head:* light orange-brown with central area and between ocelli and eyes yellowish. Ocelli whitish with inner margins black. Eyes of male with upper portion reddish-brown, lower portion black. Eyes of female black. Antennae: scape and pedicel light brown, flagellum yellowish, paler toward apex. *Mouthparts:* clypeus, labrum, basal 2/3 of mandibles, basal 1/2 of maxillae and segment I of palpi and labium brownish, remaining parts lighter. Medial denticle on anteromedian emargination of labrum much larger than others (Fig. 8H). Tusk on inner apical margin of maxillae of medium size, similar to Figure 10C. *Thorax:* nota bright orange-brown, with black markings as in male imago, medial line yellowish, pleura and sterna yellowish-brown, washed with black as in male imago. *Legs:* light brown, with coxae washed with black and black markings as in male imago, but smaller; numerous short, pointed spines on dorsum of femora II-III. Claws light brown, apex orangish. *Abdomen:* terga bright orange-brown, darker posteriorly, black markings as in male imago; sterna yellowish washed with black, darker anteriorly. Gills yellowish, trachea and fimbriae blackish. Caudal filaments brownish lighter toward apex.

Material: Holotype, male imago, ARGENTINA, Misiones, Inta San Vicente, 30/XI/86, E. Domínguez col. (IFML); Paratypes: 1 male imago, 1 male subimago, 3 female subimagos, 40 nymphs. All deposited at IFML, except 10 nymphs in (FAMU) and 10 nymphs in (NMNH). The association of the adult and nymphs was made from rearing by E. Domínguez.

Etymology: misionensis, from Misiones Province, Argentina, where this species was collected.

Variation: The male paratype color is lighter than in the holotype, especially in the abdominal pattern.

Discussion: The nymph of *U. misionensis* was used to characterize *Ulmeritoides* (Domínguez, 1991) and all illustrations referred to as "*Ulmeritoides* sp." are of this species.

Ulmeritoides misionensis can be separated from the other species of the genus by the following combination of characters. In the imagos: 1) forewings (Fig. 8A) hyaline, with costal and subcostal areas light brown, stigmatic area much lighter; 2) abdominal color pattern as in Figure 8D, E; 3) 10 cross veins basal to bulla in forewings; 4) penis as in Figure 8F, G. In the nymph: 1) medial denticle on anteromedian emargination of labrum much larger than others (Fig. 8H); 2) tibiae I with subbasal and subapical black bands; 3) dorsum of femora II–III with numerous short, pointed spines; 4) femora II with median black spot.

Ulmeritoides tifferae, new species

Holotype male imago (in alcohol). Length: body, 6.8–7.2 mm; forewings, 8.0–8.2 mm; hind wings, 1.9–2.0 mm. General coloration: brownish, abdomen slightly washed with black. *Head:* light orange, heavily washed with black. Upper portion of eyes yellow-brown, lower portion blackish. Ocelli white, heavily washed with brown laterally, blackish basally. Antennae: scape and pedicel light brown, flagellum

lighter. *Thorax:* pronotum light brown, heavily tinged with black on lateral and posterior margins, median and paramedian areas blackish; mesonotum light orange-brown, margins and carinae darker; metanotum light brown, washed with black; pleura light brown, with margins of sclerites darker; sterna orange-brown, washed with black. *Wings* (Fig. 9A–C): membrane of forewings (Fig. 9A) hyaline, costal and subcostal areas light brown, wing base brown; longitudinal veins brownish, cross veins blackish, both lighter toward hind margin; 5 cross veins basal to bulla. Membrane of hind wings (Fig. 9B, C) hyaline, tinged with brown in costal area, brown spot at base; longitudinal and cross veins in costal area brownish, darker at base, remaining veins yellowish toward hind margin. *Legs:* coxae brownish, washed with black; trochanters light brown; femora light brown with apical and medial black spot except in femora III where black spot almost joins black stain in basal half; tibiae I blackish, base lighter; tarsi and claws in fore leg yellowish washed with black; tibiae and tarsi I–IV in legs II and III yellowish, tarsi V and claws yellowish washed with black. *Abdomen* (Fig. 9D, E): terga light brown washed with black; sterna lighter. *Genitalia* (Fig. 9F, G): subgenital plate, penis and base of forceps segment I light brown, distal part of forceps segment I and segments II and III washed with black. Apex of penis lobes rounded, each with a shallow small prominence on outer margin (Fig. 9G). Caudal filaments light brown, washed with black.

Female imago: Unknown.

Mature nymph (in alcohol). Body length, 7.0–8.0 mm. General coloration: light orange-brown with areas between ocelli and eyes heavily tinged with black. Ocelli whitish with inner margins black. Eyes of male with upper portion orange-brown, lower portion black. Eyes of female black. Antennae: light yellow, paler toward apex. *Mouthparts:* clypeus, labrum, basal 2/3 and base of molars of mandibles, basal 1/2 of maxillae and segment I of palpi and labium light brown, molars and incisors of mandibles and setae on galea-lacinia of maxillae orange-brown, remaining parts lighter. Denticles on anteromedian emargination of labrum subequal (Fig. 10A, B). Tusk on inner apical margin of maxillae of medium size (Fig. 10C). *Thorax:* terga yellow-brown, with irregular black markings especially on the lateral margins, sterna and pleura light yellow. *Legs:* light brown, with coxae washed with black, apical and median blackish spots on femora, inner margin of tibiae blackish, narrow median band on tarsi dark brown; numerous short, pointed spines on dorsum of femora II–III. Claws light brown, apex orange-brown. *Abdomen:* terga light orange-brown, with black markings as in male imago; first sterna yellowish, last orangish. Gills whitish, trachea and fimbriae gray-violet. Caudal filaments bright orange-brown.

Female imago: Unknown.

Material: Holotype, Male imago: COSTA RICA, Guanacaste, Quebrada Alcornoque, Cerro El Hacha, Parque Nacional Guanacaste, 18/VII/1989, C. de La Rosa Col (INBio). Paratypes: 6 Male imagos, same data as holotype, 2 in (INBio), 2 in (FAMU) and 2 in (IFML); 18 nymphs, same data as holotype except data: 26/V/91, R. Tiffer and R. W. Flowers col., 10 in (INBio), 4 in (FAMU) and 4 in (IFML). The association of the adults and nymphs was made by the abdominal color pattern, from material collected at the type locality.

Etymology: This species is dedicated to Miss Ruth Tiffer S., former "Research Coordinator of the Guanacaste Conservation Area," who was one of the collectors of the nymphs of this species.

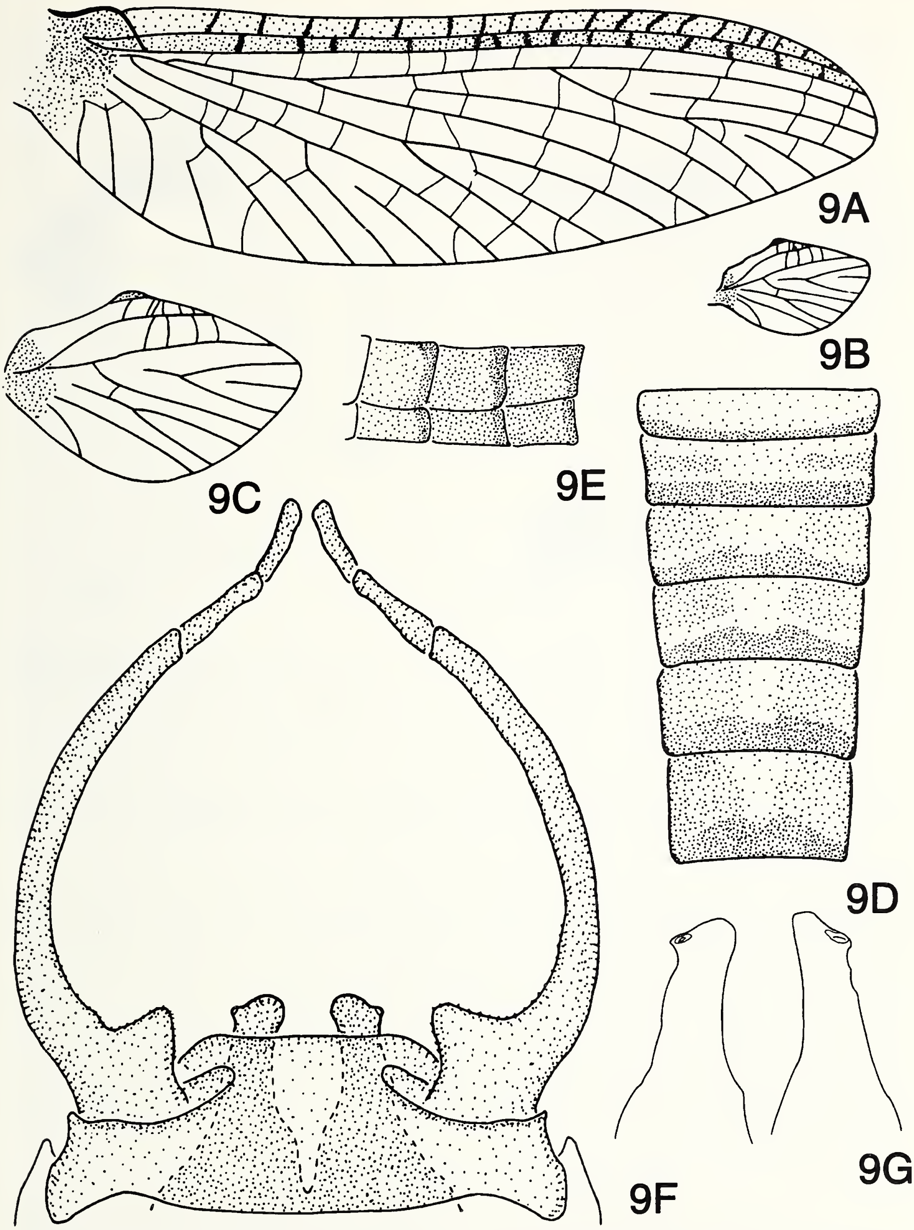
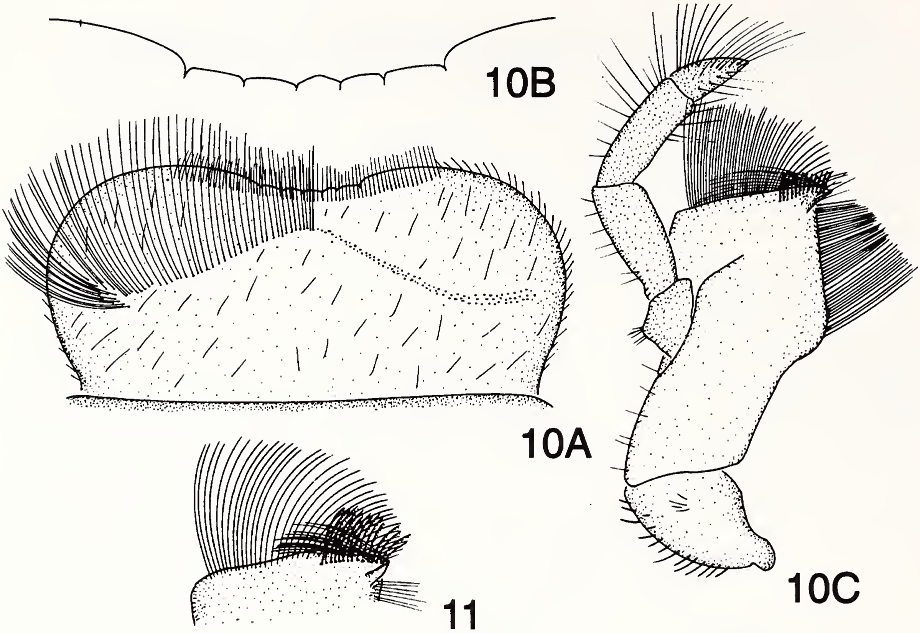


Fig. 9. *Ulmeritoides tifferae.* Male imago. A, forewing; B, hind wing; C, hind wing enlarged; D, abdominal terga II–VII; E, abdominal segments V–VII, lateral view; F, genitalia (ventral view); G, penis lobes (ventral view, enlarged).



Figs. 10–11. Nymphs. 10. *Ulmeritoides tifferae.* A, labrum (dorsal view); B, labrum (detail anteromedian emargination); C, right maxilla. 11. *Ulmeritoides guanacaste,* apex of right maxilla.

Variation: One of the paratypes has more extensive black markings on the fore legs; some of the nymphal legs are light yellow and the size of the tibial spot varies slightly.

Discussion: *U. tifferae* can be differentiated form the other species of the genus by the following combination of characters. In the imagos: 1) forewings hyaline, with costal and subcostal areas tinged with brown (Fig. 9A); 2) abdominal color pattern as in Fig. 9D, E; 3) 5 cross veins basal to bulla in forewings; 4) penis as in Figure 9F, G. In the nymph: 1) denticles on anteromedian emargination of labrum subequal (Fig. 10B); 2) tibiae I almost completely tinged with black; 3) dorsum of femora II–III with numerous short, pointed spines; 4) femora II with a median black spot.

Biology: Nymphs were collected from leaf packs and wood in a pool area of Quebrada Alcornoque.

Ulmeritoides guanacaste, new species

Holotype male imago (in alcohol, one pair of wings and genitalia on slides). Length: body, 7.2–7.5 mm; forewings, 7.6–7.8 mm; hind wings, 1.2–1.3 mm. General coloration: brownish, abdomen tinged with black. *Head:* orange-brown washed with black on anterior margins. Upper portion of eyes brownish-yellow, lower portion grayish-black. Ocelli white, ringed with black at base. Antennae: scape and pedicel yellowish, flagellum lighter.

Thorax: pronotum orange-brown with lateral and posterior margins and median and paramedian areas blackish; mesonotum bright orange-brown, margins and carinae darker; metanotum light brown; pleura light brown, with margins of sclerites darker; sterna orange-brown, washed with black. *Wings* (Fig. 12A–C): membrane of forewings (Fig. 12A) hyaline, light brown at base, stigmatic area translucent; veins C, Sc and R1 yellowish, except blackish in stigmatic area, remaining longitudinal veins whitish, except distal portions of veins Rs and MA tinged with black; cross veins in stigmatic area blackish, remaining cross veins whitish; no cross veins basal to bulla. Membrane of hind wings (Fig. 12B, C) hyaline, brown spot at base, veins C, Sc and cross veins in costal area grayish, remaining veins whitish. *Legs:* foreleg: coxae and trochanters brown, washed with black; femora light brown with a spot on apical 2/3 and apex blackish; tibiae almost completely black, except little portion at base and apex, brownish; tarsi and claws grayish-brown, washed with black; legs II and III: coxae brown, washed with black; trochanters light brown; femora II light brown with apex blackish, femora III with basal 2/3 washed with black; tibiae and tarsi yellowish washed with black; claws grayish. *Abdomen* (Fig. 12D, E): terga brownish, washed with black, especially along median-dorsal line as in Figure 12D; sterna marking similar to those of terga but with ganglial areas darker. *Genitalia* (Fig. 12F, G): subgenital plate, penis and basal 1/5 of segment I and segments II and III of forceps light brown, apical 4/5 of forceps segment I blackish. Apex of penis lobes rounded, with a small prominence on outer margin (Fig. 12G). Caudal filaments gray-yellowish.

Female imago: Unknown.

Mature nymph (in alcohol, mouthparts on slide). Body length, 5.1–5.2 mm. General coloration: bright orange-brown, with black markings. *Head:* yellowish-brown, washed with black. Ocelli whitish with inner margins black. Eyes of male with upper portion bright orange-brown, lower portion black. Eyes of female black. Antennae: scape and pedicel light yellow, flagellum whitish. *Mouthparts:* light brown except wide V shape mark that starts on clypeus and ends close to the anterior margin of labrum, base and inner 2/3 of mandibles, basal 2/3 of maxillae and maxillary palpi and mentum and base of paraglossae and base of labial palpi segment I washed with black, molars and incisors of mandibles and setae on galea-lacinia of maxillae orange-brown. Denticles on anteromedian emargination of labrum subequal in size. Tusk on inner apical margin of maxillae very small (Fig. 11). *Thorax:* nota light-brown, with black markings as in male imago, pleura and sterna yellowish, washed with black. *Legs:* light brown, black markings as in male imago; claws yellowish, apex orange-brown. *Abdomen:* terga bright yellow-orange, black markings as in male imago but more marked; sterna yellowish-white in first segments turning to yellow-orangish in last ones, all washed with black. Gills whitish, trachea and fimbriae dark gray. Caudal filaments yellow-orange, paler toward apex.

Material: Holotype, male imago: COSTA RICA, Guanacaste, Arroyo #1; Estacion Pitilla, Sendero La Laguna. 12/VI/1989, C. de La Rosa Col (INBio). Paratypes: 1 male imago, same data as holotype (FAMU), 2 nymphs, same data as holotype, except date 16/V/91, R. W. Flowers col. (INBio). The association of the adults and nymphs was made by the abdominal color pattern, from material collected at the type locality.

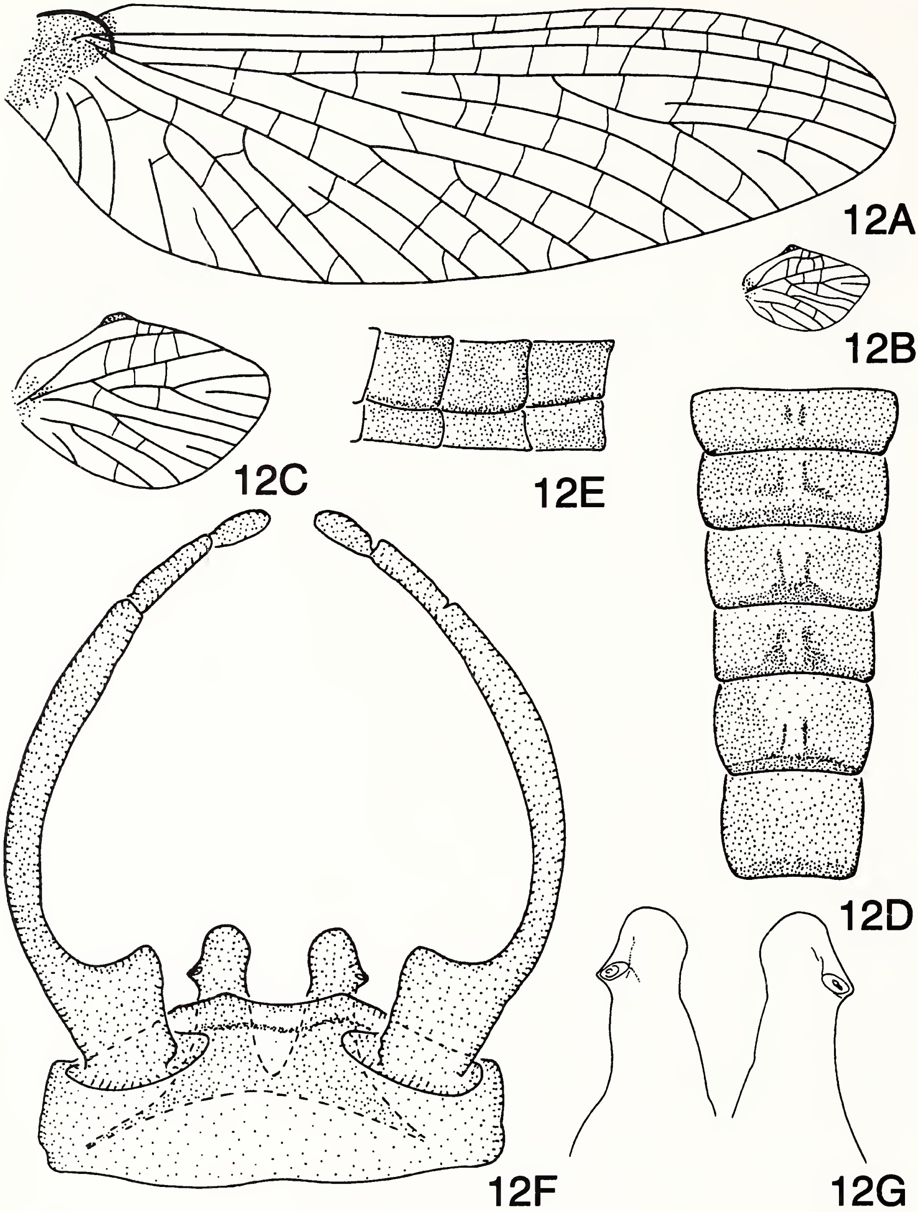


Fig. 12. *Ulmeritoides guanacaste.* Male imago. A, forewing; B, hind wing; C, hind wing enlarged; D, abdominal terga II–VII; E, abdominal segments V–VII, lateral view; F, genitalia (ventral view); G, penis lobes (ventral view, enlarged).

Etymology: Guanacaste: from the type locality, Parque Nacional Guanacaste, Costa Rica.
Variation: The male paratype is darker than the holotype, mainly in the abdominal and genital coloration. The younger nymph is light-brown.
Discussion: *Ulmeritoides guanacaste* can be separated from the other species of the genus by the following combination of characters. In the imagos: 1) forewings (Fig. 12A) hyaline, with veins C, Sc and R1 blackish at stigmatic area; 2) abdominal color pattern as in Figure 12D, E; 3) no cross veins basal to bulla in forewings (Fig. 12A); 4) penis as in Figure 12F, G. In the nymph: 1) Medial denticle on anteromedian emargination of labrum subequal in size to other denticles; 2) tibiae I almost completely tinged with black; 3) dorsum of femora II–III with few short, blunt spines; 4) femora II without median black markings.
Biology: Nymphs were found at the type locality living in leaf packs that had accumulated under a fallen log. The water current was very slow and at the date of collection (May) the water level in the stream was very low.

PHYLOGENY OF THE *ULMERITUS-ULMERITOIDES* GROUP

When Traver (1959) established the three subgenera of *Ulmeritus,* the relationships among the species within the subgenera were unknown, and only the nymph of *Ulmeritus carbonelli* was described. When analyzing the phylogenetic relationships of the *Hermanella* complex (Flowers and Domínguez, 1991), including a reared nymph of a new species of *Ulmeritoides,* it became clear that *Ulmeritus* and *Ulmeritoides* each had enough apomorphies as justify placement in different genera (Domínguez, 1991). *Ulmeritus* (*Pseudulmeritus*) *flavopedes* (Spieth) was clearly more closely related to species of *Ulmeritoides* than to *Ulmeritus* and for this reason *U. flavopedes* was transferred to *Ulmeritoides.*

But the relationships between the monobasic *Pseudulmeritus* and the other components of the group remained unknown (Domínguez, 1991). As several new species are described herein, it was necessary to establish their phylogenetic relationships in order to determine the status of *Pseudulmeritus.* When the first draft of this manuscript was completed, only adult characters were used, since nymphs of only *Ulmeritus carbonelli* and *Ulmeritoides misionensis* n. sp. were known.

Traditionally, most of the specific characters in mayflies referred to coloration and genitalic structures; these characters are difficult to polarize and even to homologize. Because the *Ulmeritus-Ulmeritoides* complex is rather homogeneous, I tried to select characters on which I could establish a transformation series to study the phylogenetic relationships.

Twelve adult characters (characters 1–12, Appendix I) were used and the polarities determined using two outgroups: *Atopophlebia,* the sister group of this complex, and *Meridialaris* which is one of the components of the sister group of *Atopophlebia* + *Ulmeritus/Ulmeritoides* (Flowers and Domínguez, 1991) as outgroups. Binary characters were coded as 0 (plesiomorphic) and 1 (apomorphic). Multistate characters were assigned different numbers indicating different apomorphies and treated as additive. Character 6 (Appendix I) is polymorphic in *Meridialaris* and was coded as "missing." In order to avoid the problems discussed by Nixon and Davis (1991), treating polymorphic characters as "missing entries," the behaviour of this character

was studied using alternative codings without any change in the results. Only characters separable into discrete states were used. Polarities were determined by outgroup comparison (Watrous and Wheeler, 1981) and following previous studies of Flowers and Domínguez (1991) and Pescador and Peters (1978).

The option used with the Hennig86 (Farris, 1988) program was ie*, the option guaranteed to find all shortest trees; only one tree was found, with a length of 29, a Consistency Index (CI) of 72 and a Retention Index (RI) (Farris, 1989) of 80.

After this analysis was completed, the nymphs of *U. tifferae* and *U. guanacaste* were made available to me, by Dr. R. W. Flowers. Using nymphs of *Ulmeritus carbonelli* and *U. balteatus* (recently obtained) and *Ulmeritoides misionensis, U. tifferae* and *U. guanacaste,* I repeated the analysis, this time using characters of both adult and nymphal stages to test the original results. 14 nymphal characters were coded (characters 13–26, Appendix I), and added to the original matrix. (The nymphal characters are separated from adult characters by an empty column in the matrix (Appendix II)). Characters 16 and 24 are treated as non-additive.

Using the same program options, the only tree obtained (length = 50; CI = 82; RI = 85) is identical in branching pattern and adult character distribution to the one based only on adults. This tree was printed with Clados (Nixon, 1992) (Fig. 13).

The analysis indicates that the *Ulmeritus-Ulmeritoides* group is monophyletic, their synapomorphies being: vein ICu2 of forewings attached to Icu1 and CuP (character 2), presence of basal swelling on segment I of forceps (character 10), basal or medial position of dorsal row of setae on labrum (character 14), dorsal row of setae on labrum entire and sinusoidal or divided (character 15), row of setae at base of outer incisor present (character 20), dorsal row of spines present on segments II and III of labial palpi (character 21), presence of lines of pectinate setae on dorsum of tibiae III (character 24) (Fig. 3A) and posterolateral projections on abdominal segments VIII-IX wide and with spines on margins (character 26). There are two major monophyletic groups, one formed by the three species of *Ulmeritus* (*U. carbonelli, U. balteatus* and *U. saopaulensis*) and the other by the species of *Ulmeritoides.* Within *Ulmeritoides, U. uruguayensis* + *U. spinulipenis* + *U. misionensis* form a monophyletic group, but it is not possible to establish the relationships among them. Their synapomorphies are: the apex of penis lobes rather straight (character 12) and denticles on anteromedian emargination present, with the median one larger (character 13(2)). With *U. flavopedes* they share characters 10(3): inner corner of basal swelling acute, which is homoplastic with *U. fidalgoi,* and as a reversal the absence of ventral projections on penis lobes (character 11). Its sister group is ((*U. guanacaste* + *U. tifferae*) + *U. fidalgoi*). Synapomorphies shared by *U. guanacaste* + *U. tifferae* are: cross veins in forewings less than 100 (character 3) and as a reversal vein ICu2 attached to ICu1 (character 2); *U. fidalgoi* share with them the synapomorphy of ventral subapical projections of penis very short (character 11(4)). These two sister groups are linked by the following synapomorphies: in forewings veins C, Sc and R1 darker than the rest (character 6(1)), which reverses in *U. tifferae* to (6); Vein Sc of hind wings less than .8 length of wing (character 8); basal swelling of forceps not rounded (character 10(2)); tusk on inner apical margin of maxillae small to medium size (character 16(1)); spines on margin of glossae few and big (character 23); and homoplastic with *Atopophlebia* are: cross veins less than 20 in

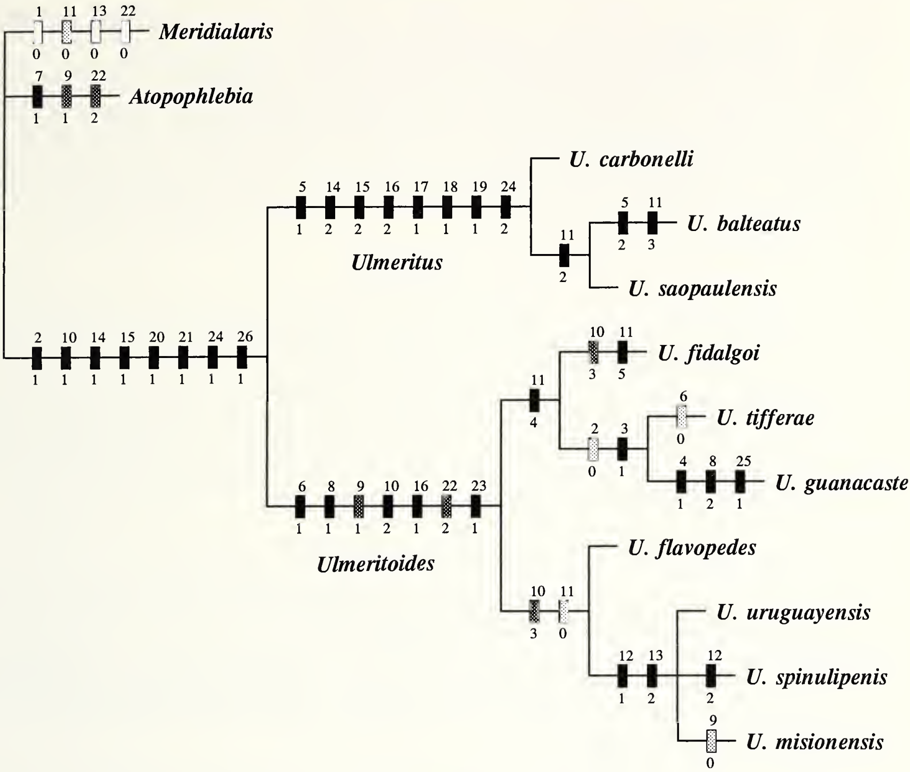


Fig. 13. Cladogram of the *Ulmeritus-Ulmeritoides* group. Black boxes = apomorphies; dark gray boxes = parallelisms; light gray boxes = reversals; empty boxes = plesiomorphies.

hind wings (character 9) and medial row of long setae on dorsum of paraglossae (22(2)).

The three species of *Ulmeritus* form a monophyletic group supported by the following synapomorphies: spots around cross veins (character 5); basal position of dorsal row of setae on labrum (character 14(2); dorsal row of setae on labrum divided (character 15(2)); tusk on inner apical margin of maxillae big (character 16(2)); palpifer of maxillary palpi enlarged (character 17); ratio segment II/segment III of maxillary palpi more than 0.9 (character 18); the outer margin of maxillae strongly curved (character 19) and line of pectinate setae on dorsum of tibiae III bifurcated at 1/2 length (character 24(2)) (Fig. 3B). *U. balteatus* and *U. saopaulensis* clade is supported by the synapomorphy: digitiform ventral projection of penis medium to short (character 11(2)).

Some characters, such as abdominal color pattern, did give some phylogenetic information. For example *U. uruguayensis, U. spinulipenis* and *U. misionensis* all have on the abdominal terga the same pattern of light rounded spot, surrounded by black (Figs. 6B, 8D), not shared by any other component of the group. This character

was not used because it was not possible to discern discrete states for the other species of the group.

The cladistic analysis supported the synonymy of *Pseudulmeritus* with *Ulmeritoides*, the monophyly of *Ulmeritus* and *Ulmeritoides* and their status as sister groups.

It is important to remember that the nymphs of many species in this analysis, including *U. flavopedes*, are still unknown. As soon as they become available, the distribution of their characters will test the pattern of relationships proposed in this paper.

ACKNOWLEDGMENTS

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APPENDIX I. CHARACTERS USED IN CLADISTIC ANALYSIS

ADULTS

FOREWINGS

1. Slanting cross vein above MA fork (< with MA approximately 45°): 0 (absent), 1 (present).
2. Attachment of Vein ICu2: 0 (attached to ICu1), 1 (attached to ICu1 and CuP).
3. Number of cross veins: 0 (more than 110), 1 (less than 100).
4. Cross veins basad to bulla: 0 (present), 1 (absent).
5. Spots around cross veins: 0 (absent), 1 (present, not forming bands), 2 (present, forming bands).
6. Coloration of longitudinal veins posterior to and in relation with C, Sc and R1: (lighter or same color), 0 (same color), 1 (lighter).

HIND WINGS

7. Location of apex of costal projection: 0 (in basal 1/2), 1 (beyond basal 1/2).
8. Length of Sc: 0 (>0.8 of wing length), 1 (<0.8 of wing length).
9. Number of cross veins: 0 (25 or more), 1 (less than 20).

MALE GENITALIA

10. Basal swelling on segment I of forceps: 0 (absent), 1 (inner corner rounded), 2 (quadrangular), 3 (inner corner acute, projecting).
11. Ventral subapical projections on penis lobes: 0 (absent), 1 (long, digitiform), 2 (medium-length, digitiform), 3 (short, digitiform), 4 (very short, shallow prominence), 5 (small, spine-like).
12. Shape of apex of penis lobes: 0 (rounded), 1 (rather straight, inner corner obtuse, margin entire), 2 (as in 1, but margin with spines).

NYMPHS

LABRUM

13. Large denticles on anteromedian emargination: 0 (absent), 1 (present, subequal), 2 (present, median one larger).
14. Dorsal row of setae: 0 (apical), 1 (medial), 2 (basal).
15. Dorsal row of setae: 0 (entire, straight), 1 (entire, sinusoidal), 2 (divided).

MAXILLAE

16. Tusk on inner apical margin: 0 (absent), 1 (present, small to medium size), 2 (present, big).
17. Palpifer size: 0 (normal), 1 (enlarged).
18. Ratio of segment III/segment II of palpi: 0 (<0.8), 1 (>0.9).

MANDIBLE

19. Shape of outer margin: 0 (evenly curved), 1 (strongly curved).
20. Row of setae at base of outer incisor: 0 (no), 1 (yes).

LABIUM

21. Dorsal row of long spines on palpi: 0 (on segment III only), 1 (on segments II and III).
22. Row of long setae on paraglossae: 0 (absent), 1 (present, apical), 2 (present, medial).
23. Spines on margin of glossae: 0 (numerous (>10), small), 1 (few (<9))

LEGS

24. Lines of pectinate setae on dorsum of tibia III: 0 (absent), 1 (almost two lines), 2 (one main line, bifurcated at 1/2 length).
25. Spines on dorsum of femora II–III: 0 (numerous), 1 (few).

ABDOMEN

26. Posterolateral projections on abdominal segments VIII–IX: 0 (narrow, with lateral setae), 1 (wide, with lateral spines).

APPENDIX II

Data matrix for the taxa used in this study. Description of character states given in Appendix I. Unknown conditions indicated by "?," polymorphic by "−." Outgroups indicated by *.

Taxon	Character state
**Meridialaris*	00000-00000? 00000000000000
**Atopophlebia*	100000101010 10000000020000
Ulmeritus balteatus	110020000130 12221111110201
Ulmeritus carbonelli	110010000110 12221111110201
Ulmeritus saopaulensis	110010000120 ??????????????
Ulmeritoides flavopedes	110001011300 ??????????????
Ulmeritoides uruguayensis	110001011301 ??????????????
Ulmeritoides spinulipenis	110001011302 ??????????????
Ulmeritoides fidalgoi	110001011350 ??????????????
Ulmeritoides misionensis	110001010301 21110001121101
Ulmeritoides tifferae	101000011240 11110001121101
Ulmeritoides guanacaste	101101021240 11110001121111

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REVIEW OF THE GENUS *COENUS* DALLAS, WITH THE DESCRIPTION OF *C. EXPLANATUS,* NEW SPECIES (HETEROPTERA: PENTATOMIDAE)

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Abstract.—*Coenus explanatus,* new species, is described from Alabama and Georgia. Diagnoses are provided for the genus as well as both previously described species, *C. delius* (Say) and *C. inermis* Harris and Johnson. A key to aid in the identification of species of *Coenus* is given.

While sorting through pentatomid specimens at the National Museum of Natural History, six specimens of an apparently undescribed species of *Coenus* Dallas were discovered. Credit for this discovery, however, must be given to H. G. Barber as one of the specimens bears the label: "*Coenus* n. sp. det. HG Barber." He apparently never described the species. It is described herein, along with a review of the genus.

The genus *Coenus,* which lacks a medial spine or tubercle on the third abdominal segment, has been placed in section one of the Pentatomini (*sensu* Rolston et al., 1980), and is included in a key to section-one genera provided by Rolston and McDonald (1984).

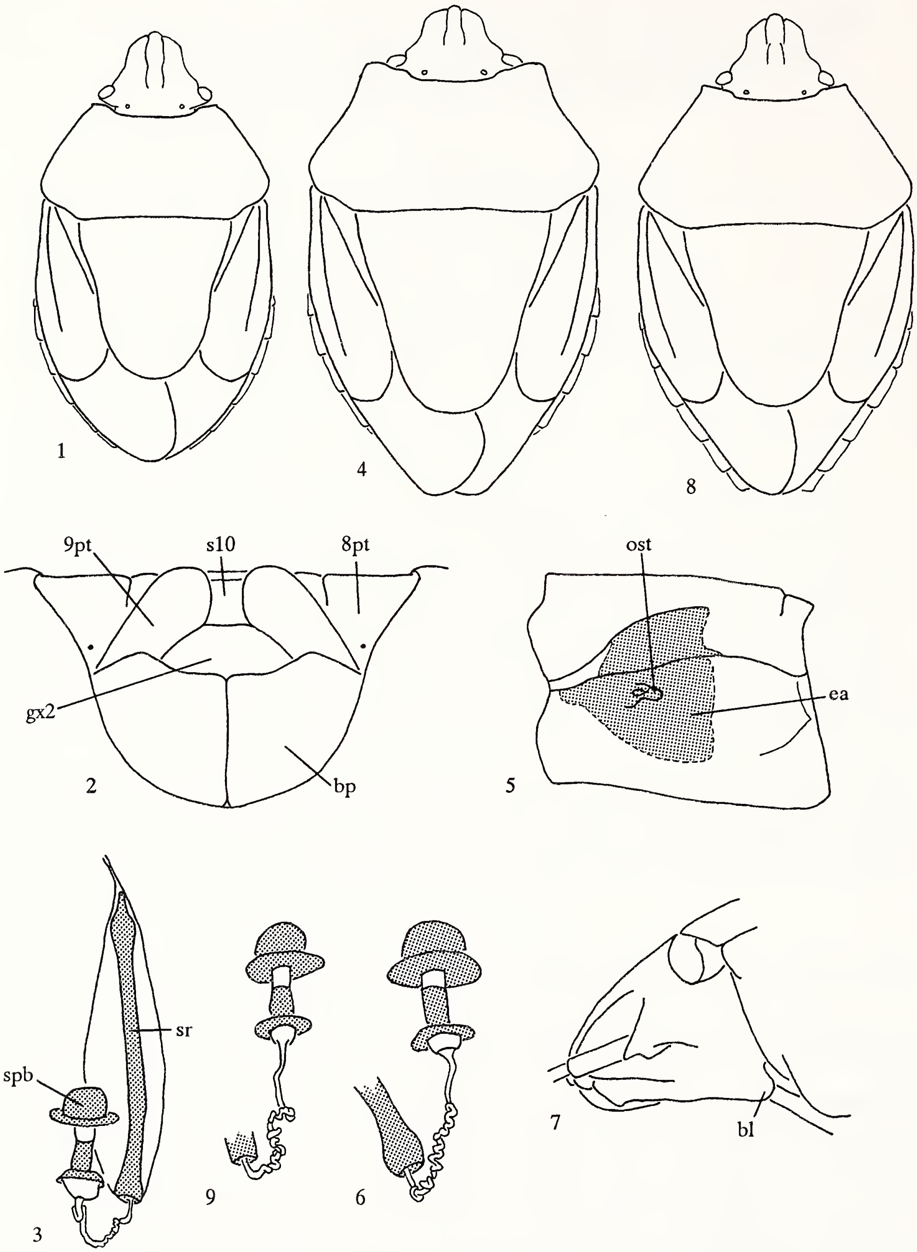
When type label data are cited in the text, each letter in parentheses represents a separate label, with (a) being closest to the specimen on the pin. Type label data are cited as written and placed within quotation marks. All measurements are in millimeters; measurements in parentheses are of the holotype.

Coenus Dallas, 1851

Coenus Dallas, 1851:194, 230; Stål, 1867:526; Kirkaldy, 1909:72.
Caenus [sic]: Lethierry & Severin, 1893:132.

Type species: *Coenus tarsalis* Dallas, 1851 [=*Pentatoma delia* Say, 1831], by monotypy.

Diagnosis. Third (second visible) abdominal sternite unarmed. Each ostiolar ruga short, auriculate, reaching less than one-fourth distance to lateral metapleural margin; evaporatoria punctured, reaching to about middle of supporting metapleural plate (Fig. 5). Each buccula distinctly lobed posteriorly, reaching to posterior margin of head (Fig. 7). Rostrum reaching to metacoxae; first segment not reaching beyond posterior margins of bucculae. Juga and tylus subequal in length. Inferior surface of each femur often armed with row of widely spaced, small spines; superior surface unarmed distally. Lateral margins of pronotum sharp, but not reflexed; anterior margin not elevated. Width of scutellum at distal ends of frena more than two-thirds basal width; apex broadly rounded, reaching to or beyond apices of coria (Figs. 1, 4, 8). Tarsi 3-segmented; coxae nearly contiguous. Prosternum and mesosternum flat



Figs. 1–9. 1–3. *Coenus delius.* 1. Habitus. 2. Genital plates, caudoventral view. 3. Spermatheca. 4–7. *Coenus explanatus.* 4. Habitus. 5. Meso- and Metapleural plates. 6. Spermathecal pump. 7. Head, lateral view. 8, 9. *Coenus inermis.* 8. Habitus. 9. Spermathecal pump. Symbols: bl, buccal lobe; bp, basal plates; ea, evaporative area; gx2, second gonocoxae; ost, ostiolar ruga; spb, spermathecal bulb; sr, sclerotized rod; s10, tenth sternite; 8pt, eighth paratergites; 9pt, ninth paratergites.

posteriorly, each with slight mesial carina anteriorly; metasternum weakly sulcate. Wing venation reticulate.

Parameres F-shaped; proctiger heavily sclerotized; aedeagus with lateral conjunctival lobes; median penial plates large; penisfilum long, coiled; dorsoposterior margin of theca tri-lobed, lateral lobes obtuse, medial lobe narrower, nearly acute; with pair of dorsal thecal appendages just dorsad of median penial plates. Mesial margins of basal plates nearly straight; posterior margins sinuous; posteromesial angles not produced caudad. Spermathecal bulb globose, lacking diverticula; spermathecal duct coiled between spermathecal pump and dilation of spermatheca.

Comments. *Coenus* belongs to a group of genera which includes the well-known genus *Euschistus* Dallas. All genera within the group possess dorsal thecal appendages which appear to be unique to this group. *Coenus* is most closely related to *Hymenarcys* Amyot and Serville, from which it can be separated by the scutellum not extending beyond the apices of coria.

Key to species of *Coenus* Dallas

1\. Anterolateral pronotal margins concave; anterior angles explanately produced anterolaterad (Fig. 4) (southeastern U.S.) .... *explanatus* new species
Anterolateral pronotal margins straight to convex; neither explanate nor anteriorly (Figs. 1, 8) 2

2(1) Maculations on superior surface of each tibia small, brown, each encircling hair; posterior margin of pygophore with distinct medial tooth (Figs. 24, 25) (east of Rocky Mountains, excluding southeastern U.S.) ... *delius* (Say)
Maculations on superior surface of each tibia large, irregular, fuscous; posterior margin of pygophore entire, lacking medial tooth (Figs. 17, 18) (Louisiana, Arkansas, Texas, Oklahoma, Kansas) .... *inermis* Harris and Johnson

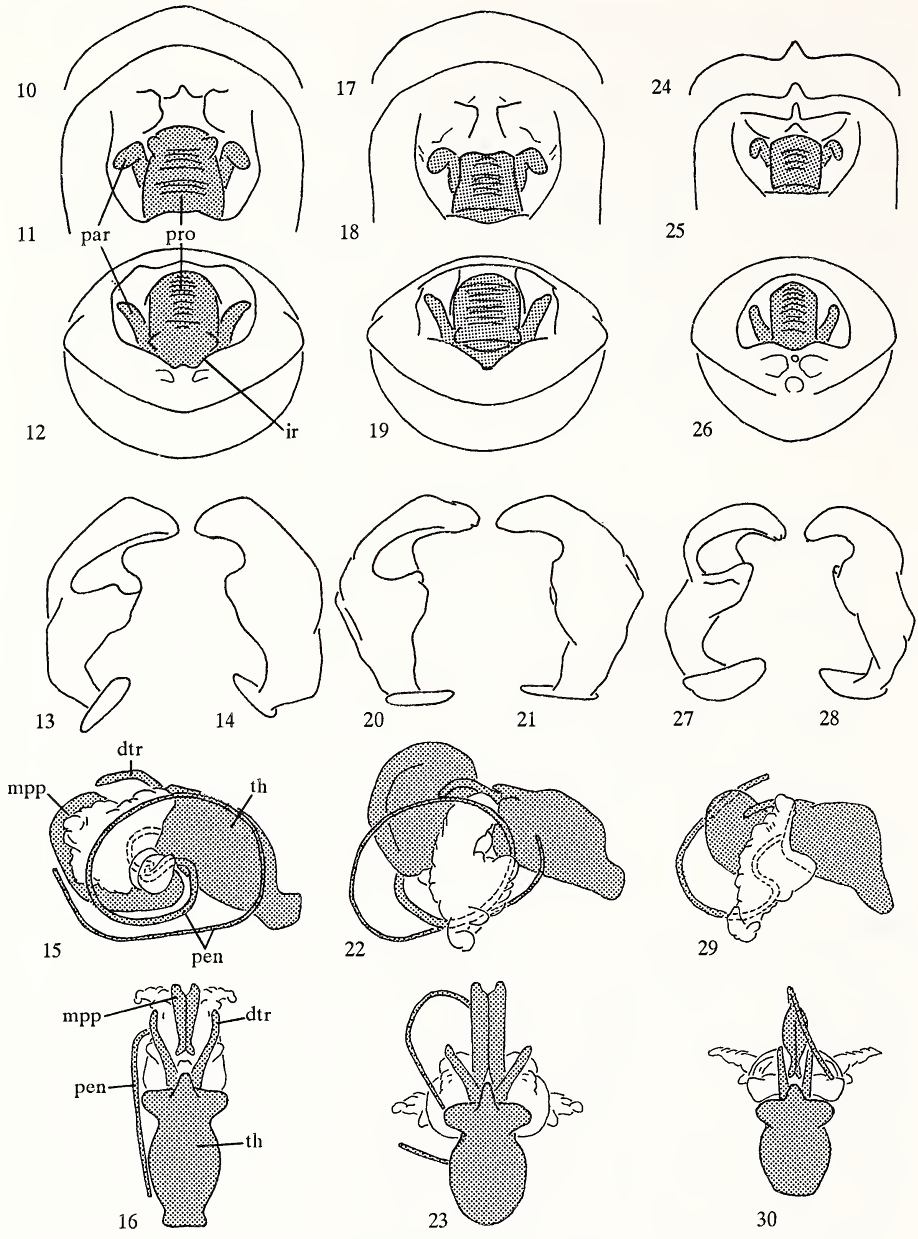
Coenus explanatus, new species
Figs. 4–7, 10–16, Map 1

Description. Oval, slightly convex dorsally, strongly convex ventrally. Dorsal surface stramineous to pale yellow-brown; punctures brown to fuscous.

Apex of head rounded; lateral jugal margins not reflexed, sinuous, not quite parallel. Surface of head relatively flat, vertex slightly convex; anterior one-third of head slightly declivant in lateral view; tylus transversely convex, slightly elevated above jugal surfaces. Punctures becoming darker and more crowded near lateral margins, relatively sparse between eye and adjacent ocellus; punctures on tylus smaller and paler than on juga, giving head appearance of having longitudinal, pale, medial band. Antennae rather uniformly red-brown to dark brown, sometimes segment V and distal one-half of segment IV slightly darker.

Anterolateral pronotal margins distinctly concave, anterior angles explanately produced anterolaterad (Fig. 4); punctures slightly more dense near humeral angles and mesially anterior to cicatrices. Pale median line on pronotum and scutellum usually obsolescent. Scutellum and coria uniformly punctured. Connexival punctures darker and more dense near segmental junctures, appearing alternated dark brown and pale yellow. Wing membranes hyaline, veins brown.

Ventral surface pale yellow, punctures brown to fuscous, becoming slightly more



Figs. 10–30. 10–16. *Coenus explanatus.* 10. Posterior margin of pygophore, ventral view. 11, 12. Pygophore. 11. Dorsal view. 12. Caudal view. 13, 14. Right paramere. 13. Lateral view. 14. Medial view. 15, 16. Theca and related structures. 15. Lateral view. 16. Dorsal view. 17–23. *Coenus inermis.* 17. Posterior margin of pygophore, ventral view. 18, 19. Pygophore. 18. Dorsal view. 19. Caudal view. 20, 21. Right paramere. 20. Lateral view. 21. Medial view. 22, 23. Theca and related structures. 22. Lateral view. 23. Dorsal view. 24–30. *Coenus delius.* 24.

dense and forming vague longitudinal, brown band on each side mesad of spiracles. Head with fuscous vitta just dorsad of each antenniferal tubercle. Rostrum pale brown, segment IV fuscous, reaching between metacoxae. Spiracles piceous. A few punctures slightly darker medially along posterior margin of each abdominal sternite, sometimes with small medial, longitudinal vitta on segment VII; anterolateral angles of each abdominal sternite with large fuscous spot. Females with elongate, transverse, pale, impunctate area on each side of median of abdominal segment III. Males with segment III as in females, but also with similar, narrower, areas on segments IV and V. Legs heavily and irregularly maculated with fuscous, including numerous spots on both sides of tibial sulcations; tibial sulcations distinct, often dark brown to black.

Posterior margin of pygophore arcuate, slightly more produced than in *C. inermis*, lacking medial tooth (Figs. 10, 11); inferior ridge broadly V-shaped, sinuous medially in caudal view (Fig. 12). Penisfilum making nearly two complete revolutions, with two to three coils or twists basally (Fig. 15). Dorsal thecal appendages abruptly curved ventrad near middle (Fig. 15). Parameres rather robust, broadest near middle (Figs. 13, 14).

Measurements. Total length excluding wing membranes 8.97–10.39 (8.97); total width 5.48–5.83 (5.48); medial length of pronotum 2.42–2.64 (2.42). Medial length of scutellum 3.81–4.21 (3.87); basal width 3.57–4.00 (3.62); width at distal end of frena 2.58–2.96 (2.58). Length of head from apex to imaginary line drawn through posterior margins of ocelli 1.97–2.04 (2.03); width 2.60–2.73 (2.66); intraocular width 1.81–1.86 (1.82); intraocellar width 1.02–1.13 (1.07); ocellar diameter 0.05–0.08 (0.07); distance from eye to adjacent ocellus 0.46–0.41 (0.45). Length of segments I–V of antennae 0.52–0.61 (0.53), 0.64–0.80 (0.64), 1.10–1.27 (1.22), 1.01–1.09 (1.01), and 1.31–1.44 (1.42), respectively. Length of segments II–IV of rostrum 1.58–1.75, 0.70–0.86, 0.69–0.82 (unable to measure holotype), respectively.

Holotype. ♂, labeled (a) "Adel, Ga 8-11-39 J. D. Beamer" (b) "K. U." deposited in the National Museum of Natural History (Washington, D.C.).

Paratypes. 2♂♂, 3♀♀. 1♀ labeled as holotype (USNM); 2♂♂ labeled "Ga." (DAR, USNM); 1♀ labeled (a) "Florala, Ala. 1938 L. Henderson" (b) "K. U." (DAR); and 1♀ labeled (a) "TIFTON GA 6-30-1936" (b) "Collected on cotton" (c) "P. A. Glick Coll." (d) "Coenus n. sp. det HGBarber" (USNM).

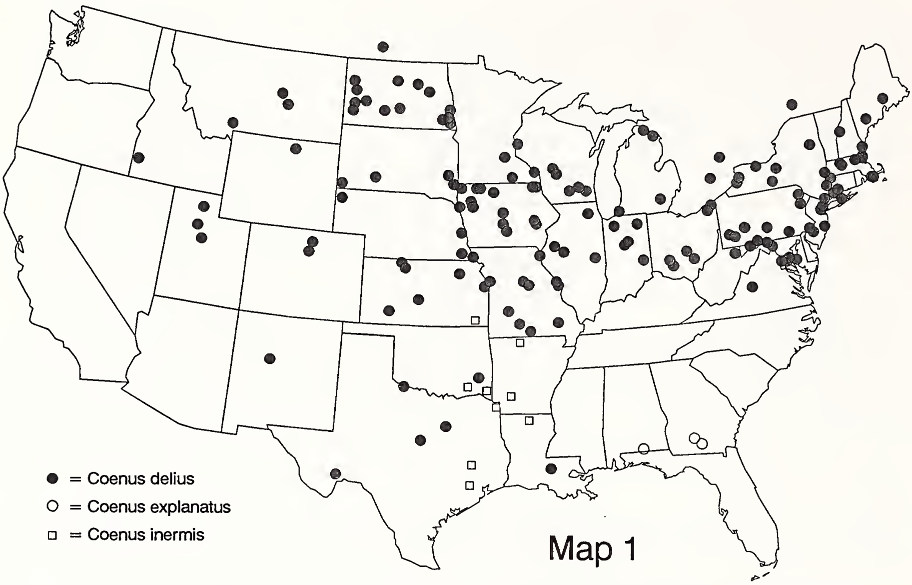
Distribution. Southeastern U.S. (Map 1).

Comments. This species is closely related to *C. inermis*, but can be separated from it and *C. delius* by the form of the anterolateral pronotal margins.

All members of the type series were collected in the 1930's; I have not seen any specimens collected more recently. It appears that this species may either be extinct or at least very rare.

←

Posterior margin of pygophore, ventral view. 25, 26. Pygophore. 25. Dorsal view. 26. Caudal view. 27, 28. Right paramere. 27. Lateral view. 28. Medial view. 29, 30. Theca and related structures. 29. Lateral view. 30. Dorsal view. Symbols: dtr, dorsal thecal appendages; ir, inferior ridge; mpp, median penial plates; par, parameres; pen, penisfilum; pro, proctiger; th, theca.



Map 1. United States distribution of *Coenus delius* [●], *C. explanatus* [○], and *C. inermis* [□].

Etymology. This species is named for the distinctive condition of the anterolateral margins of the pronotum.

Coenus delius (Say)
Figs. 1–3, 24–30, Map 1

Pentatoma delia Say, 1831:8; Say, 1859:320.
Hymenarcys aeruginosa Amyot & Serville, 1843:125. (syn. by Stål, 1872).
Coenus tarsalis Dallas, 1851:230, pl. 8, fig. 6. (syn. by Stål, 1867).
Coenus punctatissimus Vollenhoven, 1868:183. (syn. by Stål, 1872).
Coenus delius: Kirkaldy, 1909:72; McPherson, 1982:68–69; Froeschner, 1988:573–574.

Diagnosis. Antennae red brown to dark brown, usually segment V and distal one-half of segment IV distinctly darker. Anterolateral pronotal margins straight to slightly convex; anterior angles not produced or explanate (Fig. 1). Pale median line usually relatively distinct on pronotum and scutellum; pronotal punctures usually relatively dense along anterolateral margins, especially anteriorly. Abdominal segments III–V lacking pale, impunctate areas in both males and females. Maculations on legs rather uniform, relatively sparse; those on superior surface of each tibia limited to very small spot at base of each hair.

Posterior margin of pygophore in dorsal and ventral views truncate with distinct medial tooth (Figs. 24, 25); inferior ridge sinuous in caudal view (Fig. 26). Penisfilum making one complete revolution, not coiled at base (Fig. 29). Dorsal thecal

appendages rather uniformly curved ventrad (Fig. 29). Parameres relatively narrow, shaft of each somewhat sinuous (Figs. 27, 28).

Types. Most of Say's types have been destroyed. The identity of this species is now well established.

Distribution. This species occurs from the Rocky Mountains eastward, but is apparently absent from the southeastern U.S. (Map 1).

Specimens examined. CANADA: Ontario: Brantford; Mer Bleu; Toronto. **Quebec:** Montreal; jct. rtes. 52 & 13. **Saskatchewan:** Oxbow.

UNITED STATES: Colorado: *Boulder:* Boulder. *Larimer:* Ft. Collins. **Connecticut:** *Fairfield:* Norwalk; Stamford; Westport. *Litchfield:* Lakeville. **District of Columbia:** Flats; Rock Crk. **Idaho:** *Canyon:* Caldwell. **Illinois:** *Champaign:* Champaign. *Du Page. Mason:* Havana. *Warren:* Swan twp. **Indiana:** *Cass:* 0.5 m. S. Galveston. *Fayette:* Connerville. *Howard:* NW Howard Co. *Noble:* Sylvan Lake. *Starke:* Knox. **Iowa:** Nichole. *Allamakee:* Harpers Ferry; Waukon. *Buena Vista:* Sioux Rapids. *Dickinson:* Lake Okoboji. *Emmet:* Estherville. *Johnson:* Hills; Iowa City; Solon. *Kossuth:* Algona. *Lyon:* Little Rock. *Muscatine:* Muscatine. *Polk:* Des Moines. *Sac:* Sac City. *Story:* Ames. *Warren:* Indianola. *Woodbury:* Sioux City. **Kansas:** *Ford:* Bloom. *Johnson. Phillips. Riley:* Clearwaters. *Rooks. Stafford:* Salt Flats. **Louisiana:** *E. Baton Rouge:* Pride. **Maine:** Pretty Marsh. *Kennebec:* Augusta. *Penobscot:* Orono. **Maryland:** Crampton Gap; Meyersville; Plummer's Isl. *Allegany:* Cumberland. *Anne Arundel:* Odenton; 5 km SW Odenton, Ft. Meade. *Frederick:* Wolfsville. *Prince Georges:* Beltsville; Silver Hill. *Washington:* Hagerstown. **Massachusetts:** *Barnstable:* Monument Beach; Woods Hole. *Essex:* Andover; Lynn; Swampscott. *Hampshire:* Amherst; Cummington; Hadley; Northampton. *Middlesex:* Sherborn; Tyngsboro. **Michigan:** *Berrien:* Warren Dunes. *Cheybogan:* Douglas Lake. *Presque Isle:* Ocqueoc Lake. *Washtenaw:* Ypsilanti. **Minnesota:** *Freeborn:* Albert Lea. *Hennepin. Winona:* Homer. **Missouri:** Dameron. *Boone:* Ashland Wildlife Area; Columbia. *Callaway:* Tucker Prairie. *Howell:* West Plains. *Jackson:* Kansas City. *Lewis:* Canton. *Polk:* 3.5 m. SE Flemington. *St. Charles:* St. Charles. *St. Louis:* Clayton; Manchester; St. Louis. *Wayne. Wright:* Mountain Grove. **Montana:** *Gallatin. Musselshell:* Montana Expt. Stn., Musselshell. *Petroleum:* 1.5 m. S, 5 mi W Winnett. **Nebraska:** *Douglas:* Omaha. *Johnson:* Sterling. *Richardson:* Falls City. *Sioux:* Glen. **New Hampshire:** *Grafton:* Pike. *Rockingham:* Hampton. **New Jersey:** Beatyestown; Brookside. *Camden:* Delair. *Morris:* Madison. *Ocean:* Lakehurst. *Passaic:* Great Notch. *Union:* Roselle Park. **New Mexico:** *Bernalillo:* Cibola Natl. Forest. **New York:** Adirondack Mts., Bronx Park; Cascade Lake; Allegany St. Pk.; Flushing; Fort Montgomery; Sangerties; Wading River, Long Island. *Columbia:* nr. Claverack; Hudson. *Dutchess:* Fishkill. *Erie:* Buffalo; Hamburg *Genesee:* Oakfield. *Hamilton:* Indian Lake. *Monroe:* Rochester. *Onondaga. Orange:* Pine Island; West Point. *Suffolk:* Cold Spring Harbor, Long Island. *Tompkins:* Ithaca; McLean Bogs. **North Dakota:** Tekio. *Benson. Billings:* Easy Hill; Theodore Roosevelt National Park. *Burleigh:* Bismark. *Cass:* Fargo. *McHenry. Mckenzie:* Theodore Roosevelt National Park. *Morton. Nelson. Richland:* Hwy 27, 5 mi W Hwy 18. *Ransom:* Lisbon; McLeod; 4 mi N McLeod. *Slope:* Burning Coal Vein; Chalky Buttes. *Williams:* Williston. **Ohio:** *Ashtabula:* Jefferson. *Clinton. Geauga:* Bainbridge. *Highland. Hocking. Licking:* Buckeye Lake. **Oklahoma:** *Latimer.* **Pennsylvania:** Philadelphia; Springbrook. *Allegheny:* Pittsburgh. *Cambria:* Patton. *Fulton:* Warfordsburg. *Mon-*

roe: Pocono Lake. *Perry:* 1.3 mi NW New Bloomfield. *Wayne:* Honesdale. *Westmorland:* Greensburg; Jeannette; nr. Rector. *York:* 2 mi W Airville. **South Dakota:** *Fall River:* Ardmore. *Jackson:* Weta. *Lake:* Madison. *Minnehaha:* Sioux Falls. **Texas:** *Brewster:* Hwy 90, 1.1 mi W Pecos Co. *Brown:* Bangs. *Tarrant:* Ft. Worth Nature Center. *Wilbarger:* Vernon. **Utah:** *Salt Lake. Utah:* Spanish Fork. *Weber:* Ogden. **Virginia:** Middle Mt.; Thornton's Gap. *Fairfax:* Vienna. *Nelson.* **West Virginia:** *Preston:* Cathedral St. Park. **Wisconsin:** *Dane:* Madison. *Jackson:* Black River Falls. *Jefferson:* Watertown. *Monroe:* Warrens. *Polk:* Osceola. *Waukesha:* Pewaukee. **Wyoming:** *Sheridan:* Big Horn.

Comments. This species averages slightly smaller than either *C. explanatus* or *C. inermis.* It lacks the impunctate areas on the base of the abdomen, the maculations on the tibiae are smaller and more sparse, and the medial tooth on the posterior margin of the pygophore is diagnostic.

Coenus inermis Harris and Johnson
Figs. 8, 9, 17–23, Map 1

Coenus inermis Harris & Johnson, 1936:378; McPherson, 1982:68; Froeschner, 1988:574.

Diagnosis. Antennal segments rather uniformly red-brown to dark brown, sometimes segment V slightly darker. Anterolateral margins straight, anterior angles not produced or explanate (Fig. 8). Pale median line on pronotum and scutellum usually obsolescent. Females with elongate, transverse, pale, impunctate area on each side of median of abdominal segment III. Males with segment III as in females, but also with similar, narrower areas on segments IV and V. Maculations on legs relatively large and irregular, including many large maculations on each side of tibial sulcations; tibial sulcations relatively shallow.

Posterior margin of pygophore smoothly arcuate in both dorsal and ventral views, lacking medial tooth (Figs. 17, 18); inferior ridge well-developed, V-shaped in caudal view (Fig. 19). Dorsal thecal appendages rather abruptly curved ventrad near distal one-third (Fig. 22); penisfilum making nearly two complete revolutions in opposite direction than *C. delius* or *C. explanatus*; not coiled or twisted basally (Fig. 22). Parameres rather robust, broadest near middle (Figs. 20, 21).

Types. This species was described from 1♂ and 3♀♀ specimens from Arkansas and Oklahoma. The holotype was examined, and is conserved in the U.S. National Museum of Natural History, Washington, D.C.

Distribution. Arkansas, Louisiana, Kansas, Missouri, Oklahoma, Texas (Map 1).

Specimens examined. Arkansas: *Hempstead:* Hope. *Marion.* **Kansas:** *Montgomery:* Elk City. **Louisiana:** *Union.* **Oklahoma:** *Atoka:* 7 mi. S Atoka. *McCurtain.* **Texas:** *Bowie:* Maud. *Brazos:* College Station. *Colorado:* Alleyton.

Comments. This species is also relatively rare. It is closely related to *C. explanatus* from which it is easily distinguished by the shape of the anterolateral pronotal margins.

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I would like to thank all those individuals at various institutions who generously lent specimens pertinent to this study. Special thanks go to T. J. Henry, U.S. National Museum of Natural

History, Washington, D.C., who arranged for me to work at the USNM at the time the specimens of *C. explanatus* were discovered, and the holotype of *C. inermis* was examined. I would also like to thank G. Fauske, and H. J. Meyer, North Dakota State University, J. A. Moore, Fargo, ND, and L. H. Rolston, Louisiana State University, for their comments on an early draft of the manuscript.

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PROTOPOLYBIA BITUBERCULATA, A NEW NEOTROPICAL SOCIAL WASP (HYMENOPTERA: VESPIDAE; POLISTINAE)

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Abstract.—*Protopolybia bituberculata*, a new polistine species from the Neotropics, is described and the nest illustrated.

Protopolybia Ducke is a genus of small neotropical social wasps, belonging to a tribe, Epiponini, the members of which found new colonies by swarms of queens and workers (Carpenter, 1993). The most recent revision (Richards, 1978) recognized 23 species, but with the synonymy of *Pseudochartergus* with *Protopolybia* (Carpenter and Wenzel, 1990) five more species are now included in the genus, for a total of 28. To this total we are adding a new species.

The presently described species has not been properly recognized as a distinct taxon. Ducke (1910:475) misidentified it as a color form of *Protopolybia sedula* var. *exigua* (Saussure). In the collection of the Goeldi Museum there are specimens labelled *Protopolybia minutissima* var. *sedula* (Saussure), probably following the revision of the genus by Bequaert (1944). This latter name is a misidentification of *Protopolybia exigua* (see Richards, 1978). The name *sedula* is the senior synonym of a different species, called *Protopolybia pumila* (Saussure) by Bequaert (Richards, 1978).

Protopolybia bituberculata, new species
(Figs. 1A, 2A, 3)

Protopolybia sedula var. *exigua* (de Saussure): Ducke, 1910:474 (in part). Misidentification.

Diagnosis: Propodeum with posterior face projecting symmetrically to either side of median furrow, forming two moderately high protuberances (Fig. 1A); first metasomal tergum petiolate, clearly longer than wide at apex. Male genitalia with the medial lobes of the aedeagus pointed laterally and strongly sclerotized (Fig. 2A). Small species; color brown or black and yellow.

Description:

Female: Mean forewing length 4.0 mm. *Structure*—cuticle finely reticulate, unpunctured except for shallow punctures on posterior margin of metasomal segments; clypeus a little higher than wide, ventral margin forming a rounded median lobe; dorsal pronotal carina low, obtuse, but distinct at sides, gradually sloping posteriad on the humeri; fovea well developed, anterior carina low, obtuse; mesoscutum as long as wide; scutellum slightly convex with an incomplete median line; metanotum

about 1.25× as wide as long, lobe moderately acute apically; propodeum with posterior surface projecting to either side of the median furrow, forming two moderately developed protuberances (Fig. 1A); first tergum about 1.2 times longer than wide at apex, with a distinct basal petiole; second tergum a little wider than long, about twice as wide as first tergum at apex.

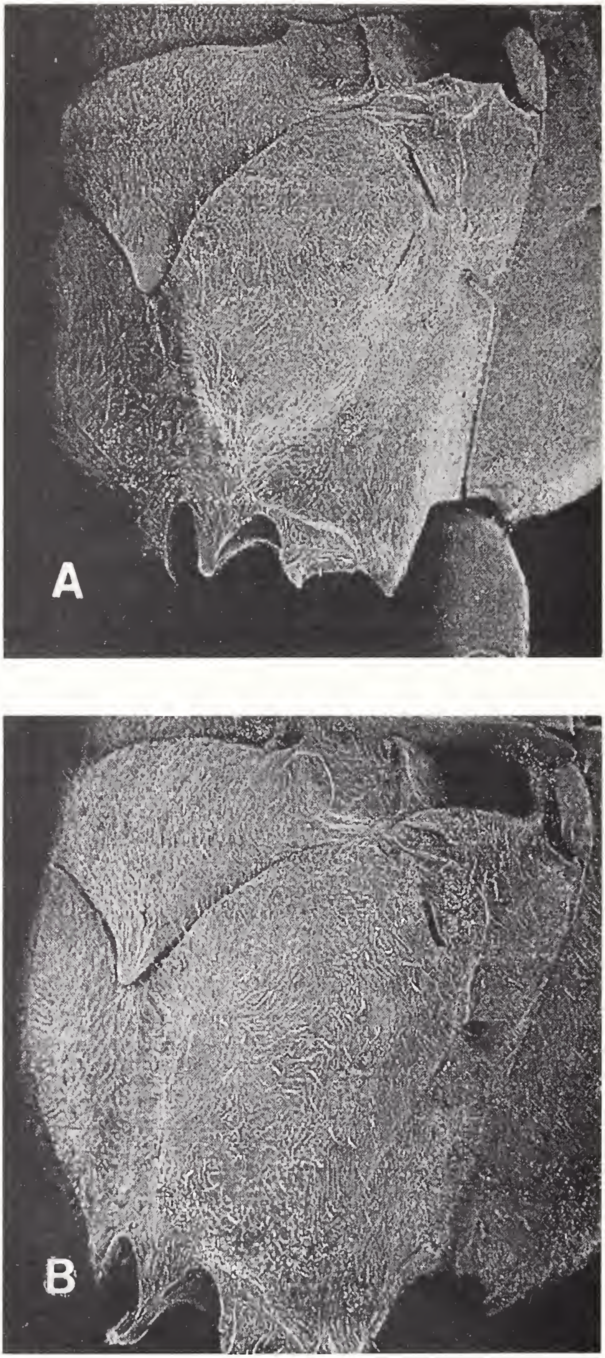
Color—ground color black to brown; margin of mandibular teeth and ventral margin of clypeus, reddish; antennae testaceous brown to black, scape yellow beneath with flagellum orange; abundant yellow markings, including most of clypeus aside from central inverted bifid mark, bifid frontal mark, ocular loops, most of pronotum except band on anterior surface down to level of foveae and humeral mark, two narrow stripes on mesoscutum, large mesepisternal mark, sometimes connected to spot below scrobe posteriorly, most of tegula yellow except outer margin, most of scutellum, axilla, and metanotum anteriorly, spot on upper part of metapleuron, most of propodeum except two antero-dorsal spots and central stripe, all of forecoxae, trochanters and femora ventrally, midcoxae anteriorly, posterior margin of first tergum, broad transverse band on second tergum basally, posterior bands on terga II–V, two lateral spots on base of second sternum, posterior bands on sterna II–IV; wings hyaline with dark brown venation.

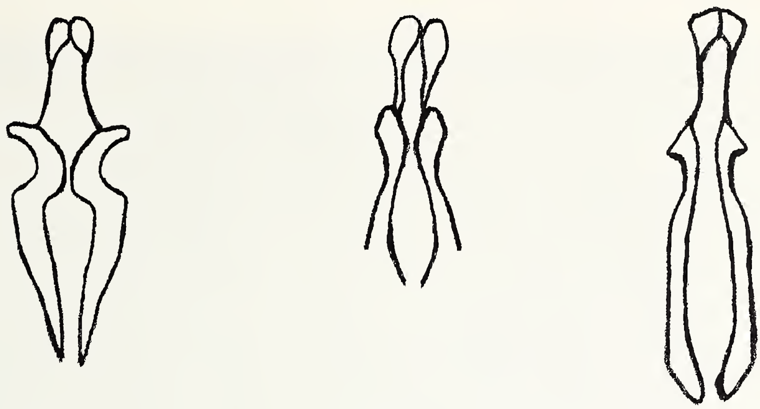
Vestiture—body covered by short appressed pubescence and more scattered short outstanding bristles, sometimes lacking in poorly preserved specimens; longer hairs on lower margin of clypeus, on propodeum, and distal metasomal segments.

Variation: The color pattern described above is not constant but the degree of variation is nevertheless small, with regard to differences in the proportions of yellow and dark. The yellow on the legs is variable, with often the tibiae and tarsi, and most of the forelegs, yellow. The specimens from Peru and Ecuador tend to be darker, and to have the propodeal protuberances somewhat more pronounced.

Male: General structure and color like the female, aside from the usual sexual dimorphism. Clypeus narrower and ventrally somewhat depressed, extensively covered by silvery hairs; antennae with 13 articles; eyes more swollen below; genae narrower; last metasomal sternum is flattened. There is proportionally less yellow, so that on the vertex two small yellow spots are defined behind the posterior ocelli, and the pronotum has just narrow transverse and humeral yellow stripes. The second metasomal tergum has a pair of basal spots, not a transverse band.

The male genitalia appear to provide excellent diagnostic features. They are quite different from *P. bella* (von Ihering) (based on dissection of a male from Panama), *P. exigua exigua* (male from Brasil, Goiás), *P. holoxantha* (Ducke) (specimen from Guyana), *P. panamensis* (Zavattari) (specimen from Panama), *P. sedula* (Saussure) (two males from Peru, Loreto), *P. weyrauchi* (specimen from Peru, Junín) and *P. wheeleri* Bequaert (specimen from Panama). Most notably, the medial lobes of the aedeagus taper to laterally-directed points and are strongly sclerotized in *bituberculata* (Fig. 2A), appearing almost like hooks. In the other species examined, these lobes are apically more or less truncate (although differing in shape, Fig. 2b, c, and with a nipplelike tubercle in *panamensis*), directed ventrally, and much more weakly sclerotized. In the other species the volsella projects as a distinct medial angle in ventral view, about where the cuspis joins the lamina volsellaris ventral to the base of the digitus, but it is essentially flat in *bituberculata.* A definitive judgement on


A
B



A B C

Fig. 2. Aedeagus, ventral view. A, *Protopolybia bituberculata.* B, *P. exigua binominata.* C, *P. weyrauchi.* The magnification is 62.5×.

the utility of these characters, however, must await study of more species of *Protopolybia,* which like other polistines have received little study of male genitalia.

Nest: Nine colonies of *P. bituberculata,* including nests, were collected by JMC and John W. Wenzel in Ecuador and Peru. A further two nests were seen in the Goeldi Museum collection. The nests show typical features of the genus (Fig. 3). The comb is suspended from the supporting leaf by one central and several lateral auxiliary peduncles, and is covered by an envelope with one or more lateral exit-holes. The envelope is brown, usually mottled with whitish streaks which may be spot-like. The envelope ranges in shape from more or less oval (e.g., Fig. 3A, 30 × 20 mm) to quite slender and spindle-shaped (e.g., Fig. 3B, 45 × 15 mm). Six of the nests from Peru and Ecuador, and one from Brasil, were somewhat enveloped by the adjacent leaves, to which the envelope was attached. In three of these nests, 901224-10, 901225-6 and 901227-3, the comb followed the curvature of the supporting leaf, to the extent that the comb almost folded back on itself lengthwise. In one of the Brazilian nests, a second lateral comb was being constructed (Fig. 3B), and in nest 901227-3 a complete second comb was separate and provided with its own envelope. One of the nests, 901217-19, was incipient, with a single naked comb (17 × 15 mm) suspended by a central peduncle. In another nest, 901229-6, the comb was only partly covered by the envelope.

Distribution: Brasil: Amazonas, Pará, and Maranhão; Peru: Loreto; Ecuador: Napo.

Type material: holotype female Brasil, Pará, Vigia, Campo do Palha, 08-xii-1988 (I. S. Gorayeb). Paratypes: Brasil, Amazonas, Tefé, 9-1904, 1 female, 28-9-1904, 1

←

Fig. 1. Propodeum, oblique posterior view. A, *Protopolybia bituberculata.* B, *P. exigua binominata.*

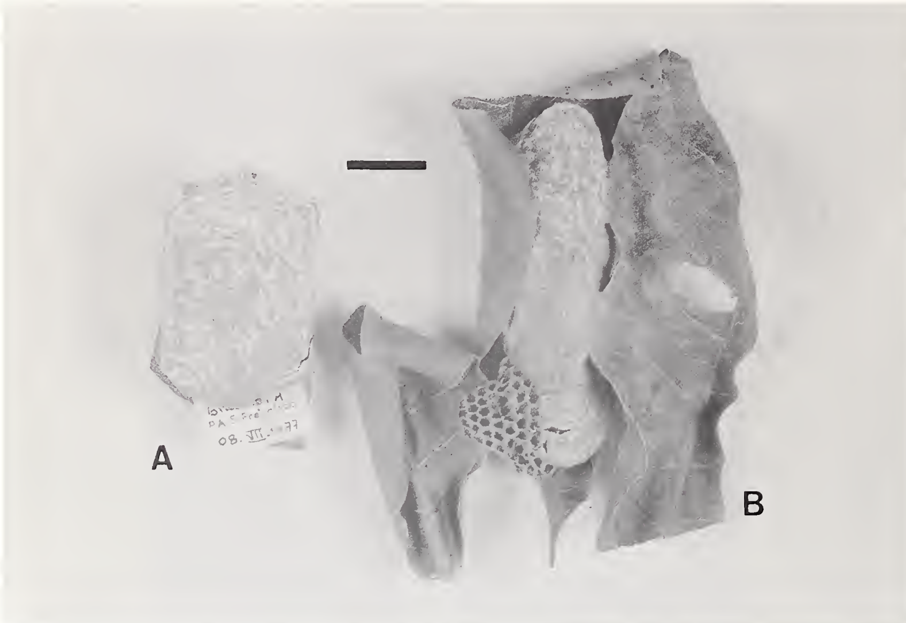


Fig. 3. Two nests of *P. bituberculata*. The scale bar is 1 cm.

male; Maranhão, S. Luiz, 3-6-1907, 1 female; Pará, Benevides, 81-911, 3 females; Pará, 16-12-1911, 1 female; 1912, 1 female (A. Ducke); Pará, Belém, Utinga, 14-xi-1967, 12 females (R. L. Jeanne); Pará, S. Francisco, 8-vii-1977, 13 females (W. L. Overal); Pará, S. Miguel, 11-iv-1979, 24 females (F. F. Ramos, W. França, and R. B. Neto); Pará, Vigia, Campina, 7-xii-1988, 1 female (I. S. Gorayeb); Pará, Capitão Poço, 25-ii-1978, 1 female (W. França); Amazonas, Alvarães, 17-6-1994, 26 females (O. T. Silveira and I. S. Gorayeb); Peru, Loreto, 80 km NE Iquitos, 22-12-1990, nest 901222-10, 81 females, 2 males (J. M. Carpenter and J. W. Wenzel); Loreto, 80 km NE Iquitos, 22-12-1990, nest 901222-14, 11 females (J. M. Carpenter and J. W. Wenzel); Loreto, Rio Sucusari at Napo, 24-12-1990, nest 901224-10, 240 females, 4 males (J. M. Carpenter and J. W. Wenzel), 4 females emerged 25-12-1990; Loreto, Rio Sucusari at Napo, 25-12-1990, nest 901225-6, 170 females, 31 males (J. M. Carpenter and J. W. Wenzel); Loreto, 80 km NE Iquitos, 27-12-1990, nest 901227-3, 70 females (J. M. Carpenter and J. W. Wenzel); Loreto, 40 km NE Iquitos, 29-12-1990, nest 901229-6, 26 females, 1 male (J. M. Carpenter and J. W. Wenzel); Loreto, 40 km NE Iquitos, 29-12-1990, nest 901229-7, 218 females (J. M. Carpenter and J. W. Wenzel); Ecuador, Napo, Tena, 16-12-1990, nest 901216-12, 115 females preserved in ethanol (J. M. Carpenter and J. W. Wenzel); Napo, Tena, 17-12-1990, nest 901217-19, 40 females (J. M. Carpenter and J. W. Wenzel).

Holotype and 93 paratypes deposited in the Goeldi Museum (Museu Paraense Emílio Goeldi, Belém/PA, Brazil). More than 1000 paratype specimens in the American Museum of Natural History (New York, USA).

Etymology: the specific name is a reference to the outstanding diagnostic feature of *P. bituberculata,* the posterolateral propodeal projections.

REMARKS

Protopolybia bituberculata is evidently related to those species of the genus in which the first metasomal segment is petiolate, being longer than broad at the apex, and the propodeal concavity is a narrow furrow. These are probably derived traits, but phylogenetic relationships among the species of *Protopolybia* are unclear (Carpenter and Wenzel, 1990). In the key of Richards (1978), *P. bituberculata* runs to couplet 7, which leads either to *P. rubrithorax* Bequaert or *P. exigua* (Saussure). *P. rubrithorax* has a color pattern unique in the genus, with the pronotum and mesoscutum light reddish and the metasoma mostly black. It also has a very localized distribution, hitherto recorded only from Peru. *P. exigua* is most similar in color to *P. bituberculata* but, as shown above, is readily distinguished by the propodeum and the male genitalia. In *P. bituberculata* the posterior face of the propodeum projects on each side of the median furrow (Fig. 1A). In *P. exigua* that surface is evenly rounded, not projecting (Fig. 1B). Males of *P. bituberculata* differ from *P. exigua* in having the medial lobes of the aedeagus pointed laterally and strongly sclerotized, appearing hooklike (Fig. 2A) rather than truncate (Fig. 2B).

Ducke (1910:475) treated his specimens of *P. bituberculata* from Belém and Tefé (Brazil, Amazonia) as variants of *P. sedula* var. *exigua,* recognizable by a ferruginous ground color. Ducke treated this color form as corresponding to *Polybia palmarum* Blanchard, described from Guatemala and according to Ducke (1910:474), a synonym of *P. sedula* var. *exigua.* This synonymy was questioned by Bequaert (1944: 110), because Bequaert had not seen *P. sedula* [= *exigua*] specimens from north of Panama. Bequaert also commented on the very poor description of *Polybia palmarum* given by Blanchard saying "The figures of the nest, as well as the size of the wasp, merely allow the conclusion that it was a *Protopolybia.*" While noting that Ducke apparently saw specimens of *Polybia palmarum* at the Paris Museum, Bequaert concluded as more probable that Blanchard's species was in fact *Protopolybia acutiscutis* (Cameron), a species common in Guatemala. The name *palmarum* was overlooked by Richards (1978), but one of us (JMC) has seen 10 females in the Paris Museum, labelled "Mexique" and marked as types of *palmarum.* These are evidently syntypes despite the imprecise locality; the specimen bearing the type and determination label is also labelled as *exigua* by Buysson. Six of the specimens are callows, paler than the other specimens and with crumpled wings. Their color is fundamentally yellow, as stated by Blanchard, not ferruginous as stated by Ducke. However, Ducke's synonymy with the typical form of *exigua* is correct, and *bituberculata* is quite distinct from this taxon.

ACKNOWLEDGMENTS

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TWO NEW SPECIES OF *RHAGOVELIA* FROM THE PHILIPPINES, WITH A DISCUSSION OF ZOOGEOGRAPHIC RELATIONSHIPS BETWEEN THE PHILIPPINES AND NEW GUINEA (HETEROPTERA: VELIIDAE)

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Abstract.—Two new species of *Rhagovelia* are described from the Philippines: *R. ridicula* from Mindanao, Leyte, and Luzon, and *R. phoretica* from Negros. *R. ridicula* belongs to the *orientalis* group as defined by Polhemus and Polhemus (1988), being the apparent sister species to *R. aberrans* Andersen, while *R. phoretica* belongs to a distinctive intrageneric clade defined herein as the *caesius* group, whose only other members occur on New Guinea. The male paramere of *R. werneri* Hungerford and Matsuda is figured, and its structure is shown to be correlative to that of a monphyletic group of species occurring on New Caledonia and in the highlands of New Guinea, thus supporting the placement of this species in the *novacaledonica* group of Polhemus and Polhemus (1988). The evidence of a sister area relationship between the Philippines and New Guinea as indicated by the disjunct distributions of taxa in the *caesius* and *novacaledonica* species groups is discussed, and possible tectonic mechanisms that could have led to such a disjunction are evaluated.

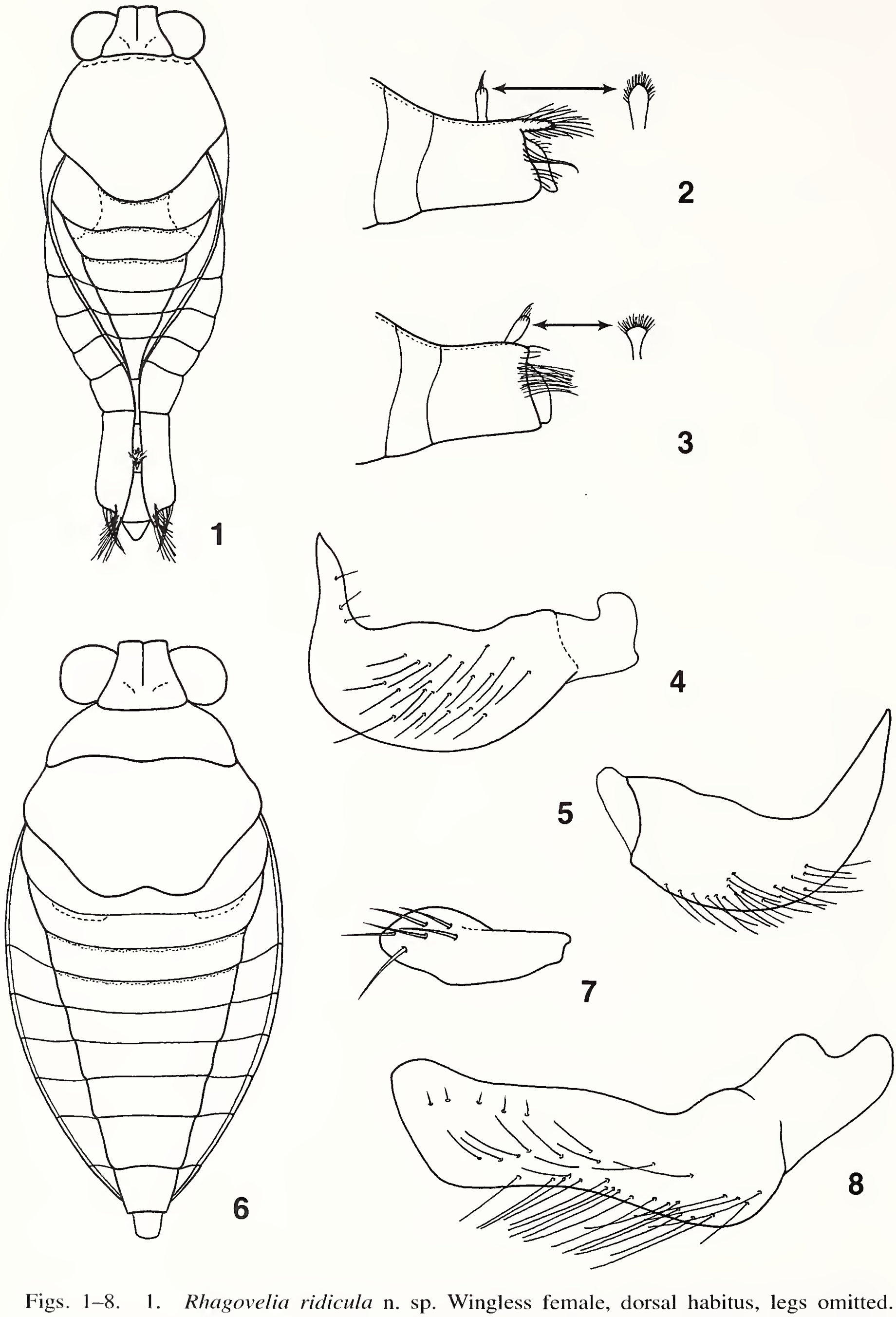
Seventeen species of *Rhagovelia* were described from the Philippines prior to 1993 (Lundblad, 1936, 1937; Drake, 1948; Hungerford and Matsuda, 1961; Andersen, 1965; Polhemus and Reisen, 1976). Of these, *R. hoberlandti* Hungerford and Matsuda has proved to be a synonym of *R. kawakamii* (Matsumura) (Polhemus and Reisen, 1976), *R. teretis* Drake a synonym of *R. luzonica* Lundblad, and *R. mindanaoensis* a synonym of *R. orientalis* Lundblad (Polhemus and Polhemus, 1989), leaving fourteen valid names. Many additional species are present, including the two new taxa described herein, and a synthetic revision of the Philippine *Rhagovelia* fauna currently in preparation by Herbert Zettel of the Naturhistorisches Museum Wien, Austria, will raise the total even further. Polhemus and Polhemus (1988) discussed the overall composition of the Philippine *Rhagovelia* fauna in the context of species groups they had proposed, and commented in passing on the zoogeographic affinities of these taxa. This present paper amplifies on that work, providing descriptions of several new species important to the zoogeographical comprehension of the region, and discussing in greater detail the faunal disjunctions between the Philippines and New Guinea seen in certain *Rhagovelia* species groups, and the tectonic mechanisms that may have produced such patterns.

TAXONOMY

Rhagovelia ridicula, new species

Figs. 1, 2, 5, 9

Diagnosis: Similar to *R. aberrans* Andersen, but distinguished by the differing shape and placement of the erect process arising from female abdominal tergite VII (compare Figs. 2 and 3), and the shape of the male paramere (compare Figs. 4 and 5).



Figs. 1–8. 1. *Rhagovelia ridicula* n. sp. Wingless female, dorsal habitus, legs omitted. Specimen from Cabigaan River, Leyte. 2. *Rhagovelia ridicula* n. sp. Lateral view of female terminal abdomen, showing location and structure of vertical process. 3. *Rhagovelia aberrans*

Description:

Wingless male: Form narrow and elongate, length 2.88 mm; maximum width (across posterior section of pronotum) 1.08 mm. General dorsal coloration dark grey; anterior portion of pronotum with frosty grey transverse band, extending downward onto pleural area; small dark orange spot centrally on anterior portion of pronotum behind head; genital segments black.

Head dark grey, eyes black, frons and vertex bearing scattered stiff dark setae; antennae black, all segments of relatively equal thickness, segment I pale yellow on basal 1/4, all segments covered with very short semi-recumbent dark pubescence, segment I also bearing 6–7 long stiff erect black setae, 1–2 setae of this type also present near middle of segment II; lengths of segments I–IV = 0.76, 0.40, 0.44, 0.44; proepisternum and jugum lacking black denticles.

Pronotum dark grey, anterior 1/4 frosty pruinose grey, length/width = 0.80/0.92, completely covering mesonotum, length of exposed metanotum at midline = 0.10; anterior pronotal lobe bearing small ovate dark orange spot behind head vertex, appearing diffuse due to overlying pruinosity; pronotal surface covered with short recumbent pale setae, these setae longer on posterior margin; disk not distinctly foveate, bearing only scattered, very small, deep pits.

Abdomen dark grey overlain with faint silvery pruinosity, tergite I longer than II (0.16), II–V equal in length (0.12), VI–VIII progressively longer (0.16, 0.20, 0.36 respectively); all tergites and connexival segments covered with short to moderate length semi-recumbent pale setae, connexival margins evenly tapering and convergent along their entire lengths.

Legs black, with margins of acetabulae adjoining coxae yellowish brown; all segments thickly covered with short recumbent pale setae; trochanters unarmed; fore, middle and hind femora and tibiae with scattered long erect stout black setae along anterior margins; fore femur with scattered slender erect black setae along posterior margin; fore tibia simple and cylindrical, not bent or expanded; middle femur unmodified, cylindrical, tapering, bearing a line of long slender erect black setae along posterior margin; middle tibia slender, cylindrical; hind femur and tibia with scattered long fine erect brown setae along posterior margins; hind femur very weakly incrassate, bearing a small black spine on posterior margin near middle, followed by 2–3 much smaller black spines; hind tibia straight, cylindrical, with small tuft of semi-erect black setae along anterior margin on distal 1/3.

Proportions of male legs as follows: fore femur/tibia/tarsal 1/tarsal 2/tarsal 3 = 0.92/0.88/0.03/0.04/0.20; middle femur/tibia/tarsal 1/tarsal 2/tarsal 3 = 1.60/1.20/0.04/0.68/0.64; hind femur/tibia /tarsal 1/tarsal 2/tarsal 3 = 1.28/1.40/0.04/0.04/0.28.

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Andersen. Lateral view of female terminal abdomen, showing location and structure of vertical process. 4. *Rhagovelia aberrans* Andersen. Male paramere. Specimen from Ayala River, Mindanao. 5. *Rhagovelia ridicula* n. sp. Male paramere. Specimen from Sapa River, Mindanao. 6. *Rhagovelia phoretica* n. sp. Wingless female, dorsal habitus, legs omitted. Specimen from Amulan, Negros. 7. *Rhagovelia phoretica* n. sp. Male paramere. Specimen from Amulan, Negros. 8. *Rhagovelia werneri* Hungerford and Matsuda. Male paramere. Specimen from Mt. Apo, Mindanao.

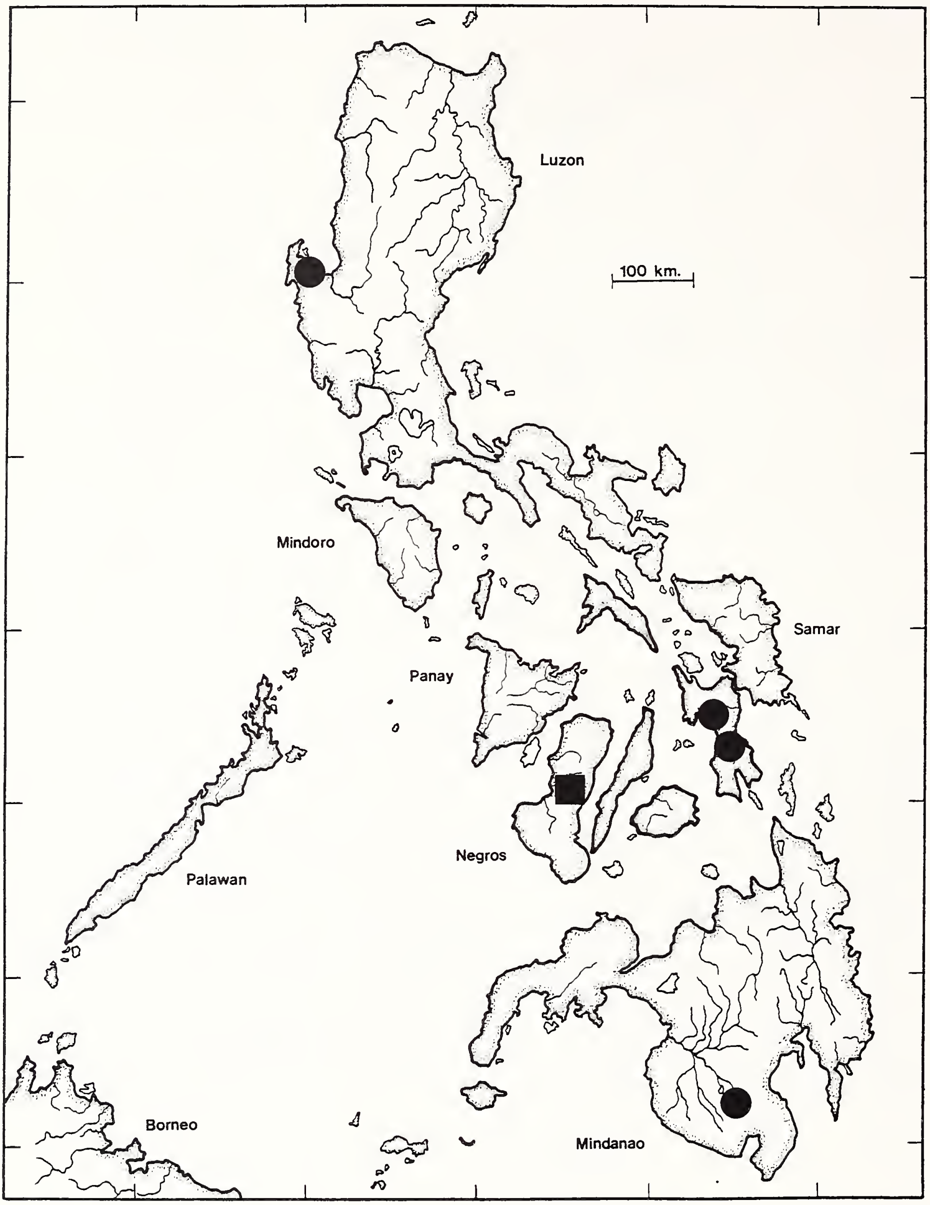

Fig. 9. Distribution of *Rhagovelia* species in the Philippines. Circles = *R. ridicula* n. sp. Square = *R. phoretica* n. sp. (exact location of type locality within island uncertain).

Venter dark grey, weakly overlain with silvery pruinosity; mesosternum, metasternum and abdominal ventrites lacking small black denticles; mesosternum with incipient triangular sulcus centrally; metasternum roughly trapezoidal; abdominal ventrite I narrow, lying in semi-vertical orientation, abdominal ventrites II–VI bulging and tumescent, lacking a longitudinal medial carina; ventrites IV–VI thickly set with long semi-erect pale setae directed posteriorly, ventrite VII with a sharp longitudinal medial carina, this carina continuing onto ventrite VIII and widening posteriorly; segment VIII (first genital segment) stout, not constricted basally; proctiger and genital capsule retracted into segment VIII, proctiger without basal lobes, distal cone coming to a broad but distinct angle; paramere falciform, shape as shown in Figure 5.

Wingless female: Length 3.36 mm; maximum width (across pronotum) 1.36 mm.; body shape as in Figure 1. Similar to wingless male in general structure and coloration with the following exceptions: lengths of antennal segments I–IV = 0.80, 0.44, 0.48, 0.48; extreme posterior margin of mesonotum visible behind posterior margin of pronotum; metanotum tumid at anterolateral angles, these swellings covered with numerous long erect black setae; connexival margins evenly converging adjacent to abdominal tergites I–V, meeting over tergite VI, then diverging slightly over tergites VII–VIII, completely covering tergites VI–VII when viewed from above; abdominal segment VII forming an elongate cylinder, with posterolateral angles produced into long projections, bearing numerous long dark setae (Fig. 2), similar setae also present along posterior margins adjacent to genital cavity; posteromedial portion of abdominal tergite VII produced to a vertical, finger-like process, projecting upward between connexival margins and bearing a fan-like fringe of setae at the apex (Fig. 2); proctiger vertical, gonocoxae recessed into abdominal segment VII, not evident; thoracic and abdominal venter lacking black denticles, abdominal ventrites lacking longitudinal medial carinae or long pale setae; hind femur not incrassate, bearing at most a single small black spine near middle.

Winged male: Length 3.16 mm., maximum width (across humeral angles) 1.37 mm. Similar to wingless male in general structure and coloration with following exceptions: pronotum expanded, length/width = 1.56/1.69, black, with anterior band silvery pruinose and bearing a small dark orange spot centrally behind head vertex, humeral angles prominent, central section tumid, posterior lobe produced to cover entire metanotum, apex coming to a broadly rounded angle, not elevated or prolonged; hemelytra exceeding tip of abdomen, bearing 3 closed cells, with 2 long cells originating in basal portion of the plus another cell in the outer portion of the distal half between the radius and the subcosta; hemelytra uniformly dull black, with basolateral cell between subcosta and radius weakly pruinose; dorsal abdominal carinae moderately long, extending to posterior margin of tergite II; hind femur with armature similar to wingless form.

Winged female: Length 3.46 mm., maximum width (across humeral angles) 1.28 mm. Similar to winged male in general structure and coloration with following exceptions: pronotum length/width = 1.75/2.23; abdomen lacking vertical projection formed by tergite VII as seen in wingless form, connexiva more widely separated, revealing all abdominal tergites when viewed from above with wings removed.

Discussion: *Rhagovelia ridicula* is a member of the *orientalis* group as defined by Polhemus and Polhemus (1988), and is closely allied to *Rhagovelia aberrans* An-

dersen. The two species may be separated by the following characters: the posterolateral connexival angles are prolonged in *ridicula* and bear long hair tufts, while in *aberrans* they are unmodified (compare Figs. 2 and 3); the vertical projection on female abdominal tergite VII emerges from between the connexival margins near the middle of segment VII in *ridicula,* but near the posterior end of the connexiva in *aberrans* (compare Figs. 2 and 3); the basal portions of the connexival margins in *aberrans* bear a thick fringe of erect black setae that is absent in *ridicula*; the posterior margin of abdominal tergite III bears a fringe of scattered long black setae in *aberrans* that is lacking in ridicula; and the male parameres of the two species are differently shaped (compare Figs. 4 and 5).

Ecological notes: The Sapa River at the type locality was a slow, shaded stream flowing in a muddy bed, and surrounded by numerous habitations and rice fields. This type of habitat may not be obligatory for *R. ridicula,* however, since it was also taken from swift, rocky streams entering the sea on Luzon and Leyte, and from the clear, rocky Hilusig River, an upland stream on Leyte. All of the localities from which *R. ridicula* is presently known lie in areas in which the original forest has been heavily disturbed or converted over to agriculture, and it is possible that this species has eluded collection up to now due to its preference for disturbed habitats considered worthless by most collectors.

On Luzon *R. ridicula* was taken sympatrically with *R. luzonica* Lundblad, *R. minuta* Lundblad, and *R. cotabatoensis* Hungerford and Matsuda. On Leyte and Mindanao, by contrast, this species was found to be sympatric with *R. usingeri* Hungerford and Matsuda, and *R. orientalis* Lundblad.

Etymology: The name "ridicula" refers to the odd and amusing abdominal modifications exhibited by this species.

Material examined: *Holotype,* wingless female: PHILIPPINES, Mindanao, **South Cotabato Prov.,** Sapa River, SE of Koronadal, 550 m, 20 July 1985, CL 1994, D. A. and J. T. Polhemus (BPBM). *Paratypes:* PHILIPPINES, Mindanao, **South Cotabato Prov.:** 1 winged female, 22 wingless males, 47 wingless females, same data as holotype (BPBM, JTPC). Leyte, **Leyte Prov.:** 3 wingless males, 9 wingless females, Lusig River at Hilusig, 15 July 1985, CL 1979, D. A. and J. T. Polhemus (JTPC); 1 winged female, 10 wingless males, 15 wingless females, Cabigaan River, S. of Ormoc, sea level, 17 July 1985, CL 1987, D. A. and J. T. Polhemus (JTPC). Luzon, **Pangasinan Prov.:** 1 winged male, 12 wingless males, 7 wingless females, stream 6 km. W. of Sual, sea level, 6 July 1985, CL 1956, D. A. and J. T. Polhemus (JTPC).

Rhagovelia aberrans Andersen

Figs. 3, 4

Discussion: *Rhagovelia aberrans* was originally described from Zamboanga, Mindanao, (Andersen, 1965), and the excellent figures accompanying the description illustrate all the salient morphological features of this species. Despite extensive recent collections in the Philippines this species has not been taken outside the Zamboanga Peninsula, indicating that it may be endemic to this area.

Ecological notes: A series of this species was taken by the author and J. T. Polhemus from the Ayala River, a large, unshaded, rocky river flowing swiftly into the sea

northwest of Zamboanga City. This habitat was very similar to localities on Luzon and Leyte from which *R. ridicula* had been taken (see above), and indicates that both of these species may have a preference for swift, open lowland streams.

Material examined: PHILIPPINES, Mindanao, **Zamboanga del Sur Prov.:** 10 wingless males, 23 wingless females, Ayala River at San Ramon, 24 km NW of Zamboanga City, 23 July 1985, CL 1999, D. A. and J. T. Polhemus (JTPC); 1 wingless male, 1 wingless female, Zamboanga, mountain stream, 27 Feb. 1914, T. Mortensen (paratypes, JTPC).

Rhagovelia phoretica, new species
Figs. 6, 7, 9

Diagnosis: Immediately recognizable among Philippine *Rhagovelia* by the broad and ovate form (Fig. 6), sexual dimorphism in body size, with males being much smaller than females, short pronotum with a length at the midline subequal to the length of an eye, and the small, ovate male paramere (Fig. 7).

Description:

Wingless female: Form broadly ovate (Fig. 6), length 3.48 mm; maximum width (across basal abdomen) 1.64 mm. General dorsal coloration dark blackish grey, with basal portions of legs yellowish brown.

Head dark blackish grey, eyes black, frons and vertex bearing scattered stiff black setae; antennae black, segment curved, I thicker than II, all segments covered with very short semi-recumbent dark pubescence, segment I also bearing 3–4 long stiff erect black setae; lengths of segments I–IV = 0.60, 0.36, missing, missing; proepisternum and jugum lacking black denticles.

Pronotum dark blackish grey, short, length/width = 1.12/0.24, broadly exposing mesonotum, posterior margin weakly bisinuate; exposed portion of tumid to either side of depressed midline, length along midline = 2.00, posterior margin biconvex posteriorly; metanotum with anterolateral portions moderately tumid, bearing scattered erect black setae, length along midline = 0.12; entire thoracic dorsum nearly bare, bearing only widely scattered very short recumbent pale setae, with a few longer stout erect black setae on pleural region.

Abdomen dark blackish grey, tergites I–VI subequal in length (0.16, 0.20, 0.20, 0.24, 0.20, 0.24 respectively), tergite VII longer (0.32), tergite VIII shorter than VII (0.28); tergites nearly bare, with only widely scattered very short recumbent pale setae, connexival segments more thickly covered with moderate length semi-recumbent pale setae.

Legs black, with all coxae, fore and hind trochanters, and basal half of fore femur yellowish brown; all segments thickly covered with short recumbent pale setae; trochanters unarmed; fore, middle and hind femora and tibiae with scattered long erect stout black setae along anterior margins; fore femur with scattered slender erect black setae along posterior margin; fore tibia cylindrical, weakly curved and slightly more setiferous distally; middle femur unmodified, cylindrical, tapering, bearing a few long slender erect black setae along posterior margin; middle tibia slender, cylindrical; hind femur with a few scattered long fine erect dark setae along posterior margin, not incrassate, unarmed; hind tibia straight, cylindrical, unarmed.

Proportions of female legs as follows: fore femur/tibia/tarsal 1/tarsal 2/tarsal 3 =

0.98/0.96/0.04/0.04/0.28; middle femur/tibia/tarsal 1/tarsal 2/tarsal 3/ = 1.40/1.20/0.04/0.52/0.84; hind femur/tibia/tarsal 1/tarsal 2/tarsal 3 = 1.00/1.40/0.04/0.05/0.40.

Venter grey; mesosternum, metasternum and abdominal ventrites lacking small black denticles; mesosternum without incipient triangular sulcus centrally; metasternum trapezoidal, unmodified; abdominal ventrite I flat, lying in horizontal orientation, abdominal ventrites II–VII lacking long setiferation or medial carinae; gonocoxae broadly exposed; proctiger lying in a semi-horizontal orientation.

Wingless male: Length 2.48 mm.; maximum width (across pronotum) 1.16 mm. Similar to wingless female in general structure and coloration with the following exceptions: body size much smaller, not as broadly ovate; dorsum of thorax and abdomen thickly covered with short, semi-recumbent dark setae; lengths of antennal segments I–IV = 0.40, 0.32, missing, missing; abdominal tergites I–III equal in length (0.12), IV and V equal in length but longer than preceding (0.14), VI and VII increasingly longer (0.16, 0.24 respectively), VIII shorter than VII (0.16); fore femur and tibia moderately bowed, modified for phoresy; proctiger with basal section bearing weakly produced lateral lobes, distal section with incipient lateral lobes but otherwise unmodified; paramere small, roughly ovate (Fig. 7).

Winged forms: Unknown.

Discussion: *Rhagovelia phoretica* n.sp. belongs to a distinctive intrageneric species group, referred to subsequently as the *caesius* group, that also contains *R. caesius* Lansbury from eastern New Guinea, and is defined by the following characters: strong sexual dimorphism, with males much smaller than females; a broad and ovate overall shape, with silvery grey ground coloration; a short and posteriorly sinuate pronotum in wingless forms; a tumid and broadly exposed mesonotum in wingless forms, with the posterior margin generally bilobate; a small, ovate male paramere; a simple and unmodified proctiger; and slender male forelegs, with the fore tibia curved and modified for grasping. Although the two above taxa are the only members of this assemblage presently described, a large number of additional undescribed species in this clade are present on New Guinea, and will be treated in a monograph on the Melanesian fauna that is currently in progress. The sister area relationship between the Philippines and New Guinea indicated by the distribution of species in the *caesius* group is consistent with the narrative zoogeographical analysis presented by Polhemus and Polhemus (1988) in their monograph of the eastern Indonesian *Rhagovelia* fauna.

Intermixed among the type series from Negros are three specimens (two males and one female) bearing the data "PHILIPPINES, Todaya, Is. Mindanao, July 30, 1970, M. Sato." It seems possible that these specimens were mislabelled, and they are thus not included as paratypes. The Mindanao record for this species, if in fact valid, needs to be reconfirmed.

Ecological notes: The type series was taken in company with *Rhagovelia usingeri* Hungerford and Matsuda, but no information is available regarding the specific habitat.

Etymology: The name "phoretica" refers to phoretic modifications of the males for riding on top of the females.

Material examined: *Holotype,* wingless female: PHILIPPINES, Negros, **Prov. uncertain,** Amulan, 16–18 July 1970, M. Sato (BPBM). *Paratypes:* PHILIPPINES,

Negros: 11 wingless males, 12 wingless females, same data as holoytype (BPBM, JTPC).

Rhagovelia werneri Hungerford and Matsuda
Fig. 8

Discussion: This species was originally described from high elevation on Mt. Apo, behind Davao, and to date no additional series have been taken. *R. werneri* is of interest in a zoogeographical context because of the structure of the male paramere, which possesses a distinctive, distally spatulate shape typical of the *novacaledonica* group as defined by Polhemus and Polhemus (1988) (Fig. 8). These authors had in fact suggested that *R. werneri* might be a member of this species group, but did not include it as such, since their primary diagnostic character for inclusion involved wing venation, and no winged specimens of *werneri* were available to them. Subsequent analysis of paramere shapes within the Melanesian and Philippine *Rhagovelia* faunas has shown that the spatulate paramere is a strong symapomorphy uniting the species of the *novacaledonica* group, and argues for the placement of *werneri* within it. In addition to *R. werneri,* this paramere shape is seen in all species from New Caledonia, and in a diverse complex of species (including *R. thysanotos* Lansbury, *R. crinita* Lansbury, *R. aureospicata* Lansbury, *R. herzogensis* Lansbury and many additional undescribed taxa) that has radiated in the highlands of New Guinea. Polhemus and Polhemus (1988) proposed a pattern of faunal relationship in which New Caledonia was an ancient continental source area for *Rhagovelia* species occurring on the younger islands of New Guinea and the Philippines, and the distribution of the *novacaledonica* group as now understood supports this hypothesis (Fig. 10), although in a somewhat revised geological context (see following discussion).

The suggestion by Polhemus and Polhemus (1988) that a second Philippine species, *R. hoogstraali* Hungerford and Matsuda, might also be assignable to the *novacaledonica* group, is not supported by the current analysis of paramere shapes. The wing venation in this species is still unknown, however, so its group affinities remain uncertain.

Material examined: PHILIPPINES, Mindanao, **Davao Prov.**: 6 wingless males, 2 wingless females, Sibulan River, Mt. Apo, 7,000–8,000 ft, 21 Sept., C. S. Clagg (JTPC); 1 wingless male, 1 wingless female, E. slope Mt. Apo, stream through original forest, 6,000 ft, November 1946, H. Hoogstraal and F. G. Werner, CHNM-Philippine Zool. Exp. (paratypes, JTPC).

ZOOGEOGRAPHY

The Philippine islands comprise a complex amalgamation of island arcs whose geological history is still poorly understood. Although certain of these arcs, such as the Sulu, Palawan, and Sangihe, may be identified as discrete systems where they emerge from the tectonic knot in the center of the archipelago, others, such as the Negros arc and the accreted terranes of the Pacific Cordillera along the east coast of Mindanao, are much more difficult to interpret. At least six accreted arc systems are present in this region (Hamilton, 1979, 1989; see figs. 79, 99, 111 in the former work), and much additional onshore geology remains to be done before the history of the area can be properly comprehended.

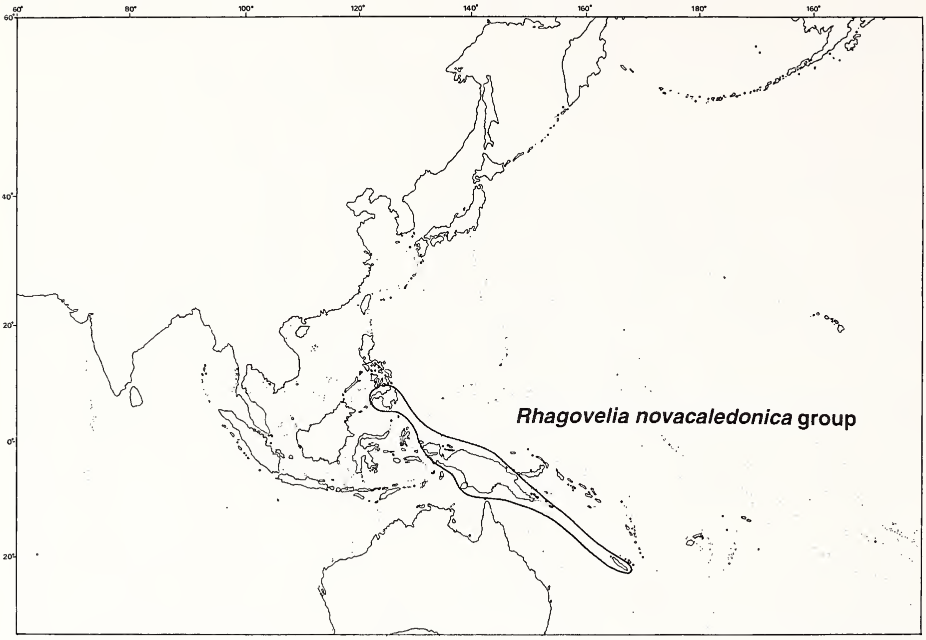

Fig. 10. Distribution of the *Rhagovelia novacaledonica* group.

The complex geology of the Philippine archipelago is reflected in the multicentric origins of its *Rhagovelia* biota, which shows alliances to disjunct groups of species occuring on Borneo, Celebes, and New Guinea. The patterns involving the former two areas were discussed in detail by Polhemus and Polhemus (1988) in their monograph on the *Rhagovelia* of eastern Indonesia, while the linkages to New Guinea were alluded to but not treated in detail. The present study illustrates much more conclusively the presence of distinctively Papuan *Rhagovelia* species groups in the southern and central Philippines, and raises the question of how such patterns were established.

Similar sister area relationships between the Philippines and New Guinea are also seen in other families of aquatic Heteroptera. Polhemus and Polhemus (1987) noted that sagocorine Naucoridae were found in both regions, but not in the intervening northern Moluccas or Celebes, a pattern apparently identical to that displayed by the *caesius* and *novacaledonica* species groups in *Rhagovelia.* In both this and the previously cited study the authors concluded that the Philippines and New Guinea represented sister areas for certain groups of aquatic Heteroptera, and postulated that a tectonic mechanism was responsible for this faunal disjunction. No simple geological explanation was evident, however, and at the time the authors had insufficient knowledge of regional tectonics to suggest any mechanistic hypothesis.

The present study further clarifies the linkages between certain elements of the Papuan and Philippine *Rhagovelia* biotas. In addition, a more thorough knowledge of regional geology now allows a mechanistic hypothesis to be advanced that would explain this pattern. It is proposed herein that a subsequently displaced, eastward

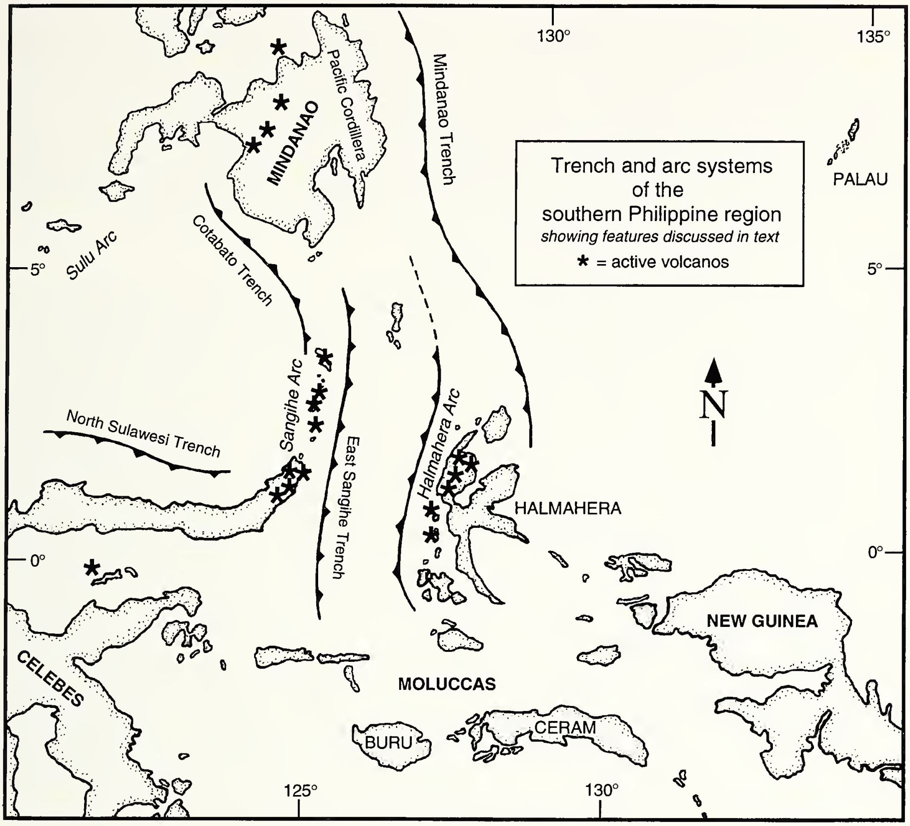

Fig. 11. Map showing selected tectonic elements in the southern Philippine and Molucca Sea regions, including island arcs discussed in the text (after Hamilton, 1979).

migrating arc system once contributed faunal elements to both the southern Philippines and New Guinea. This arc was probably not the system that was accreted to the northern margin of New Guinea in the Miocene, forming the present north coast ranges, because this Miocene arc harbored certain Asian aquatic Heteroptera groups, such as the genus *Ptilomera,* which are absent in the Philippines outside the Palawan arc. Nor was it part of the Sangihe or Halmahera arcs that were initiated in the Eocene and are presently colliding in the Molucca Sea (Fig. 11). Instead, this arc was probably part of a long, pre-Eocene, northwest-southeast trending system that once extended from New Zealand and New Caledonia through the Solomon region, past the section of northern Australia that would later become New Guinea, and onward to what is now Mindanao.

Portions of this pre-Eocene arc may be represented along the northern flank of the New Guinea central highlands in the Jimi Terrane. This anomalous crustal block contains Mesozoic volcanic rocks that appear to be the result of arc magmatism (Hamilton, 1979), but its tectonic histories are poorly understood. This terrane could

have attained its present juxtaposition by arc collision with the stable northern Australian continental margin in the Mesozoic, or could have formed offshore and have been incorporated into an advancing arc that subsequently collided with New Guinea in the Miocene (for CD-ROM video reconstruction of tectonic events in eastern New Guinea see Yan and Kroenke, 1994). Hamilton (1979) postulated that this terrane might be correlative with the eastern Australian tectonic and magmatic belts of Cretaceous age, which formed about the same time that New Caledonia migrated away from the eastern Australian continental margin (Kronke, 1984); Hamilton's suggestion is thus compatable with the zoogeographical pattern displayed by the *novacaledonica* species group of *Rhagovelia* (Fig. 10).

Arc-related materials of Cretaceous age are also present in southern Mindanao (Hamilton, 1989), and their existence is consistent with the above pre-Eocene arc hypothesis, but little is known regarding the history of these Mesozoic arc systems or whether the terranes derived from them are correlative to the Cretaceous emplacements in central New Guinea. The Pacific Cordillera of Mindanao also contains ophiolites and other remnants of more recently collided arc systems, which have been interpreted by Hamilton (1979) and subsequent workers to represent the onshore remnants of the convergent Halmahera and Sangihe arcs, which sutured along their northern sectors in the middle Tertiary (Hawkins et al., 1985), and have been subsequently overprinted by products from the more recently initiated Mindanao Trench system (for geographical locations of these tectonic structures see fig. 10). If either of these latter two arcs had provided a means for faunal interchange between New Guinea and the Philippines, either as disperal corridors or tectonic rafts, then one would also expect to see remant taxa from some of the groups involved represented in the faunas of the northern Moluccas or northern Sulawesi as well. Several aquatic Heteroptera surveys in these latter islands over the last ten years, however, including one by the author and J. T. Polhemus in 1985, have produced no collections of the groups involved in the New Guinea-Philippine disjunction. Rather than providing a linkage to New Guinea, the Sangihe Arc is currently allowing faunal interchange between Mindanao and Celebes, as demonstrated by the distribution of the *orientalis* group (Polhemus and Polhemus, 1988, and examples herein). This arc has moved eastward with time (Hamilton, 1989), and members of the *orientalis* group distributed along it have not yet reached the Moluccas or New Guinea. I hypothesize that Sangihe arc is in fact a relatively recent faunal conduit, and that the direction of *Rhagovelia* migration along it has been from the Philippines southward into Celebes, because the former area contains a diverse assemblage of species in the *orientalis* group, while the latter island has so far yielded only three (Polhemus and Polhemus, 1988; Nieser and Chen, 1993).

If a Paleocene arc did in fact formerly link the Philippines and New Guinea, then the central sector of this system must have either migrated or been displaced prior to the the development of the convergent Sangihe and Halmahera arc systems, the former of which is apparently of Eocene age (Weissel, 1980). The displacement of this older arc could have occurred along the Sorong Fault, a major left-lateral system that cuts across the extreme western tip of northern New Guinea, and has apparently transported continental fragments from the Vogelkop Peninsula eastward to near Celebes, but this is not supported by biological evidence. Conversely, fragments of this older arc could have been carried northwestward along strike-slip faults bound-

ing the western margin of the Pacific Plate, in a manner similar to that seen in the vicinity of present day New Ireland. Present plate motions and the apparent youth of the Mindanao Trench (Hamilton, 1979; Kroenke, 1984) are consistent with such a hypothesis of previous left-lateral shear in this region. Further collections of aquatic Heteroptera on the arc islands between Celebes, the Philippines and New Guinea, combined with additional geological investigations in the southern Philippines, will be necessary before these hypotheses can be more critically evaluated.

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Holotypes of all new species described herein are deposited in the Bishop Museum, Honolulu (BPBM); paratypes are held in the J. T. Polhemus collection, Englewood, Colorado (JTPC), and the U.S. National Museum of Natural History, Washington, D.C. (USNM).

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A NEW SPECIES OF *AGELAIA* LEPELETIER FROM BRAZILIAN AMAZONIA (HYMENOPTERA: VESPIDAE; POLISTINAE)

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Abstract.—A new species of the polistine genus *Agelaia* Lepeletier is described, and its relationships to other species of the genus are discussed.

The genus *Agelaia* Lepeletier (=*Stelopolybia* Ducke) is a representative of the swarming genera of the subfamily Polistinae, with essentially neotropical distribution. These genera constitute the tribe Epiponini (Carpenter, 1993). *Agelaia* has had a tangled history of name changes, documented in Araujo (1946), Richards (1978) and Carpenter and Day (1988). In the most recent taxonomic revision by Richards (1978), the genus included 22 described species.

While studying the collection of Polistinae of the Goeldi Museum, OTS discovered an undescribed species of *Agelaia* from the state of Acre. This species is close to *A. lobipleura* (Richards), and like that species shares some features with *A. cajennensis* (F.) and *A. brevistigma* (Richards). Together, these genera evidently constitute a monophyletic group.

Agelaia acreana, new species
(Fig. 1)

Diagnosis: Almost entirely yellow species; eyes distinctly hairy; clypeus with lateral margins little sinuate, diverging slightly dorsoventrally at mid-height, and markedly separated from eyes; malar space with a shining area lacking hairs; subantennal sulci evanescent (Fig. 1A); anterior margin of pronotum, at the ventral corner, with a well developed transparent lamella, but not produced very far forward (Fig. 1D); forewing with prestigma about one and a half times as long as wide, tip rounded.

Description:

Female: mean forewing length 11 mm. *Structure*—cuticle dull, very finely reticulate; clypeus broader than high, lateral margins little sinuate, diverging dorsoventrally at mid-height and markedly separated from eyes (Fig. 1A); malar space long, distance between eye and upper margin of clypeal lateral lobe almost as high as antennal socket, malar space with a slightly concave shining area lacking hairs; interantennal prominence weakly produced, with a gently convex profile as seen from above (Fig. 1B); frons with a feeble, frequently interrupted, impressed median line; subantennal sulci evanescent; posterior ocelli separated by a distance about equal to their diameter; POOL:OOL about ¼; head narrowed proportionally in lateral view, upper part of gena slightly narrower than eye in profile (Fig. 1C), occipital carina weakly developed up to middle of the swollen portion of the eye; dorsal pronotal carina very

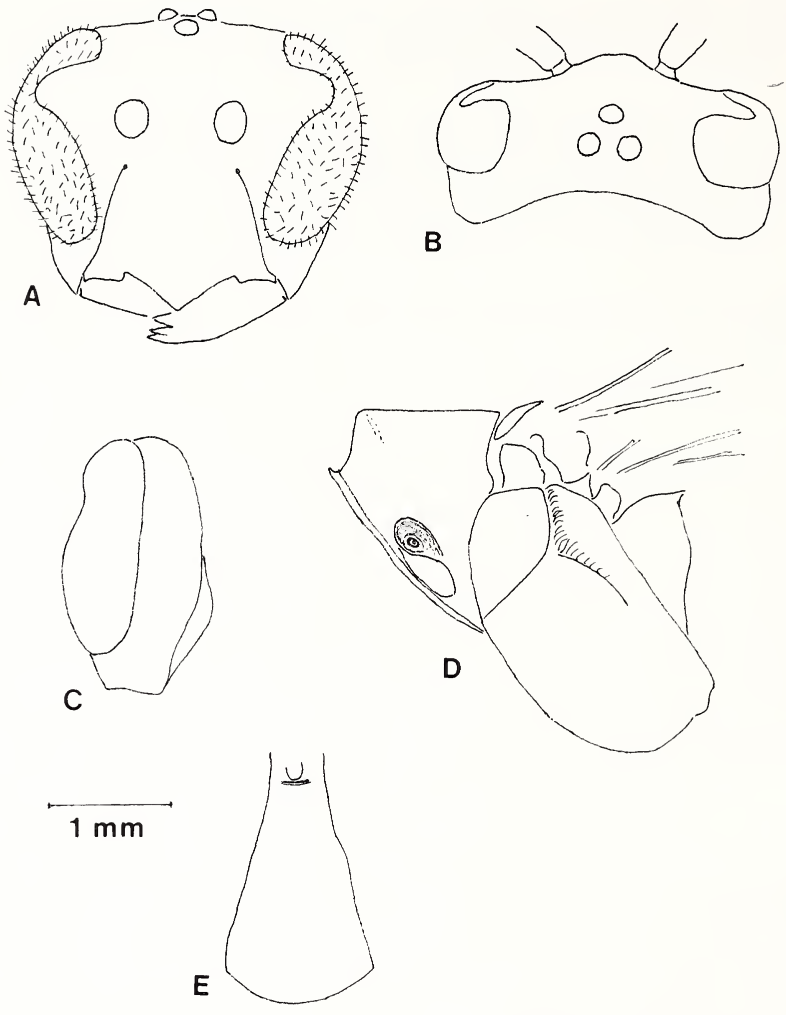

Fig. 1. *Agelaia acreana*, n. sp. A—head in frontal view; B—head in dorsal view; C—head in lateral view; D—pronotum and mesepisternum in lateral view; E—first metasomal tergum in dorsal view.

weak and obtuse but recognizable laterally; frontal margin of pronotum with a moderately developed transparent lamella widening above; fovea well developed, circular, in center of a wide concavity (Fig. 1D); anterior pronotal carina obtuse in front of fovea, lower part swollen and round; dorsal mesepisternal plate unusually wide, its height less than two times its width (Fig. 1D); impressed line on scutellum sometimes weak but distinct in front; propodeal furrow wide, not very shallow and moderately well defined; propodeal valves with a broad hyaline border; first metasomal tergum with the sides diverging gradually, spiracles not projecting (Fig. 1E);

forewing with prestigma rather long, about one and a half times as long as broad, tip rounded.

Color—yellow, but the extensive reddish pubescence gives a darker shade to the head and mesoscutum; antennal flagellum orange-yellow; ventral margin of lower metapleural plate, posterior margin and median furrow of propodeum, mesal portion of propodeal valves around the suspensory ligament, black or dark brown; most of dorsal aspect of metasomal tergum I, broad posterior bands on terga II to V, brown or light brown; wing yellow-brown, tegula yellow.

Vestiture—abundant outstanding bristle-like hairs all over the body, less conspicuous on meso- and metapleura; eyes with numerous strong, moderately long hairs.

Male: Unknown.

Type material: holotype female, Brazil: Acre, Rio Branco (25/x-8/xi-1991) F. Ramos, A. Henriques, I. Gorayeb, N. Bittencourt. Paratypes: 11 females, Acre, Rio Branco (25/x-8/xi-1991) F. Ramos, A. Henriques, I. Gorayeb, N. Bittencourt.

Holotype and 9 paratypes deposited in the collection of the Museu Paraense Emílio Goeldi, Belém, Brazil. Two paratypes in the American Museum of Natural History.

Distribution: Brazil, state of Acre.

Etymology: The specific name *A. acreana* is a reference to the Brazilian state of Acre.

REMARKS

Agelaia acreana has some uncommon features which are shared with *A. lobipleura, A. cajennensis* and *A. brevistigma.* One of these features, previously noted to occur only in the latter two species (Richards, 1978), is the presence in the malar space of a slightly concave shining area lacking hairs. Richards (1978:237, 241) characterized this area as indistinct in *A. cajennensis*, but the condition varies, and we have seen many specimens with a distinct, shining pale area, like that stated to characterize *A. brevistigma.* In *A. lobipleura* this area may have the same color as the adjacent parts of gena (it is differently colored in one paratype from Mato Grosso we have seen), but it is nevertheless distinguishable by the shining aspect and the absence of hairs. In *A. acreana* this area is as distinct as in many *A. cajennensis*, being slightly different in color from adjacent parts.

In the key of Richards (1978), an important character separating *A. cajennensis* and *A. brevistigma* from the remaining species of *Agelaia* is the shape of the prestigma of the forewing, the prestigma being relatively longer, at least one and a half times as long as broad, with the end rounded. In most *Agelaia* species it is short, not or little longer than broad, with the end truncate or pointed. The length of the prestigma actually varies in both *A. cajennensis* and *A. brevistigma*, and in *A. acreana* the prestigma has precisely the same shape as in *A. brevistigma.* Although Richards (1978) stated that in *A. lobipleura* the prestigma is short with the end truncate, we have noted that in this species (seven specimens were examined) it indeed has the end rather truncate, but it is longer than usual and never wedge-shaped as in most *Agelaia* species.

Another character shared by the above mentioned four species is the tendency shown by the lateral margins of the clypeus being divergent dorsoventrally in the middle portion, and little or not sinuate (Fig. 1A). This is accompanied by reduced

contact between the clypeus and the eyes in *A. lobipleura* and *A. cajennesis*, and complete separation in *A. acreana* and *A. brevistigma* (and a few specimens of *A. cajennesis*). These features are approached somewhat in a few other species such as *A. constructor, A. flavipennis* and *A. areata.*

The species-level phylogeny of *Agelaia* has not been studied, nor is there even a formal infrageneric classification (Richards, 1978). However, from the morphological evidence discussed above, it seems clear that *A. lobipleura, A. acreana, A. cajennensis* and *A. brevistigma* together form a monophyletic group. The presence of a concave shining area in the malar space is unique in these species, and an elongate prestigma is very probably a derived character within *Agelaia.* Besides the restricted distribution within this genus, in the closely related genus *Angiopolybia* Araujo, the prestigma is short and truncate in *A. paraensis* and *A. obidensis.* In *A. pallens*, it is sometimes longer with the end rounded, but there is much intraspecific variation. Furthermore, if the very weak dorsal pronotal carina of *A. lobipleura* and *A. acreana* is considered to be a transitional state towards its complete absence in *A. cajennensis* and *A. brevistigma*, then this provides additional support for the monophyly of a group comprising these four species. In *Angiopolybia*, the dorsal pronotal carina is also residual, but is different from the condition observed in *A. lobipleura* and *A. acreana.* In *Angiopolybia*, the carina is completely reduced at sides, and weak but nevertheless acutely produced at the center.

Among these four species, as discussed above, *A. acreana* shares some derived features with *A. brevistigma:* the shape of the prestigma, and the separation between the clypeus and eyes. But as also noted above, both of these features vary somewhat in *A. cajennensis.* On the other hand, *A. cajennensis* and *A. brevistigma* share the derived character of loss of the dorsal pronotal carina, and *A. acreana* and *A. lobipleura* both have the subantennal sulci pale and very weakly impressed, and the head narrowed proportionally in lateral view, with the upper part of the gena being slightly narrower than the eye (Fig. 1C). This distribution of apomorphies supports the inference of a sister-group relationship between *A. acreana* and *A. lobipleura* on the one hand, and *A. cajennensis* and *A. brevistigma* on the other, and we consider that to be a better established hypothesis on present evidence.

ACKNOWLEDGMENTS

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A NEW SPECIES OF *URANOCORIS* WALKER FROM NEW GUINEA (HEMIPTERA: HETEROPTERA: COREIDAE: HOMOEOCERINI)

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Abstract.—*Uranocoris maculatus* is described as a new species from New Guinea. Comparison is made with *U. suavis* Walker, which is the only previously known species of the genus. Habitus view illustrations and drawings of the male genitalia are provided to help distinguish these taxa.

This magnificent genus, of green blue metallic iridescense with shining pink and purple beams over a pale yellow surface, is known only from New Guinea. Walker (1871) described the genus *Uranocoris,* including the species *U. suavis,* which was placed in the family Anisoscelidae. For over a century this genus was kept in this classification until Osuna (1984), reviewing the generic concepts of the tribe Anisoscelidini, concluded that this tribe is exclusively from the Western Hemisphere, and transfered *Uranocoris* to the tribe Homoeocerini which has an Old World distribution.

Recently the author had the opportunity to check the type material deposited in BMNH, and to assemble a significant lot of specimens, allowing him to confirm the latest taxonomic treatment, describe the second species of the genus and provide the first specific locality of *U. suavis* in New Guinea.

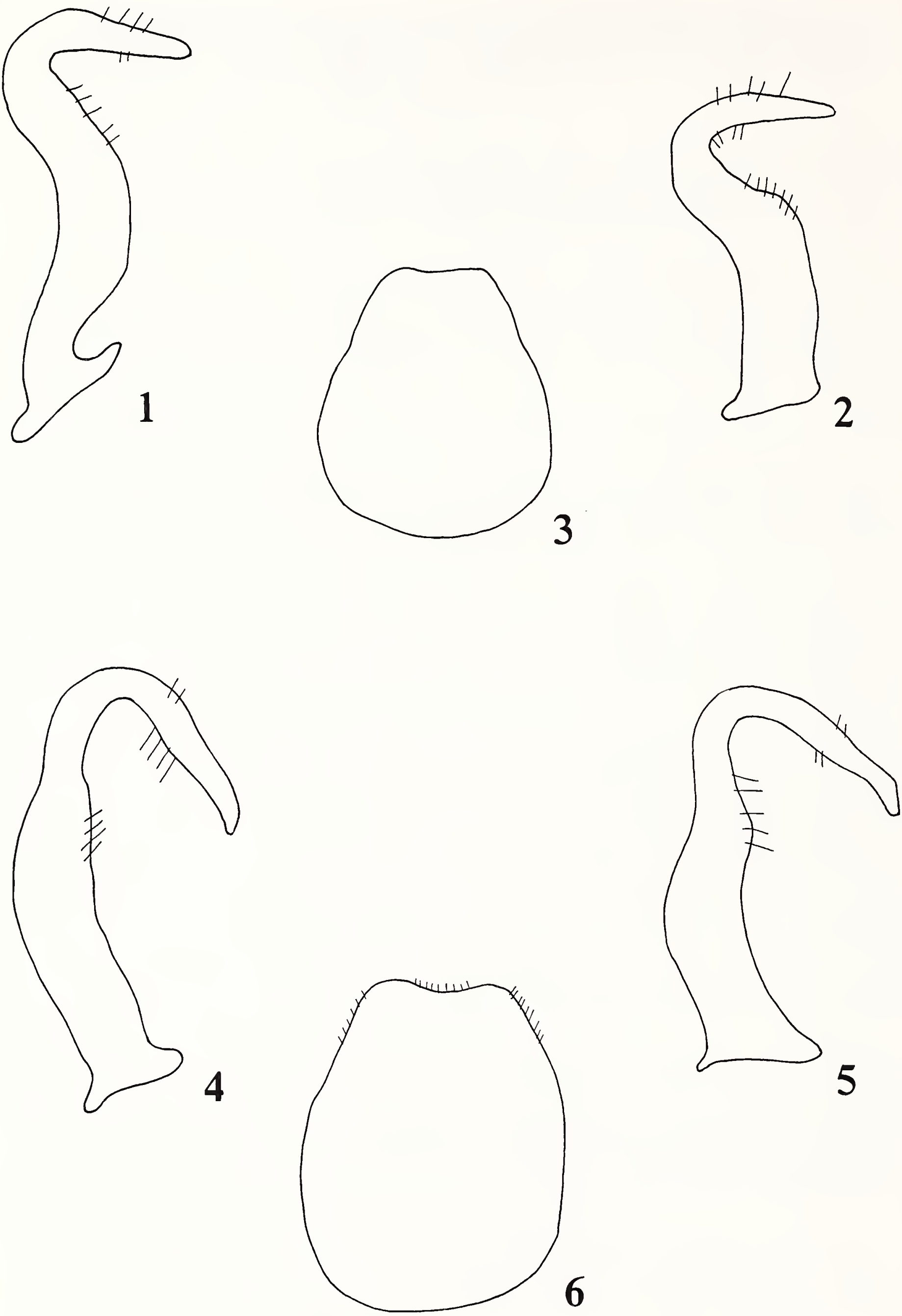
Among the diagnostic characters that separate the tribes Anisoscelidini and Homoeocerini, the following are relevant: Anisoscelidini are distributed exclusively in the new world, presenting a well developed neck, armed anterior and middle femora, and foliate posterior tibiae on one or both faces; Homoeocerini are exclusively from the Old World and have a short or absent neck, unarmed anterior and middle femora, and cylindrical and sulcate posterior tibiae; all these characters are shared with *Uranocoris.*

The following abbreviations are used in the text: Bernice P. Bishop Museum, Honolulu, Hawaii (BPBM); the Natural History Museum, England (BMNH); Instituto de Biología de la Universidad Nacional Autónoma de México (IBUNAM); Queensland Museum, Brisbane, Australia (QMBA).

All measurements are in millimeters.

Uranocoris suavis Walker
Uranocoris suavis Walker, 1871. Cat. Hem. Het: IV: 153
Figs. 4–6

This species is recognized by the shape of the parameres, with the posterior lobe longer and incurved (Figs. 4–5), the genital capsule decidedly larger (Figs. 3, 6),



Figs. 1–6. 1–3. *Uranocoris maculatus*, new species. 1, 2. Parameres. 3. Caudal view of the male genital capsule. 4–6. *Uranocoris suavis* Walker. 4, 5. Parameres. 6. Caudal view of the male genital capsule.

and by the lack of a yellow spot on the inner third of the apical margin of the corium.

Distribution

Originally described from New Guinea without any particular record.

Material examined.—One male: WEST NEW GUINEA: Star Mts. (Sibil Val), 18.X-8.XI.61. S. & L. Quate. Deposited in BPBM.

Uranocoris maculatus, new species
Figs. 1–3, 7

Male. *Dorsal coloration.* Head including antennal segments I to III bright yellow; ocelli red; external border of antenniferous tubercle brown; antennal segment IV red brown with anterior third bright orange; pronotum, scutellum, clavus and corium dark brown with following areas metallic blue green: punctures, anterior margin, anterolateral margins, humeral angles, and posterior margin of pronotum, as well as costal margin and apical angle of corial disc; following areas ochre yellow to pale yellow: callar region, apex of scutellum, and clearly discoidal spot located on the inner third of apical margin of corium; hemelytral membrane ambarine with basal angle pale hazel; connexival segments I to VI yellow, and VII bright orange, with upper margin yellow; abdominal segments I to VI with a longitudinal median stripe yellow, and laterally bright orange; segment VII with anterior half yellow, and posterior half yellow brown. *Ventral coloration.* Including rostral segments I to IV (apex of IV brown), legs, anterior and posterior lobe of metathoracic peritreme and adjacent areas yellow with three patches metallic blue green covering the pleural region of prothorax, mesothorax and metathorax; genital capsule yellow with diffusse hazel marks. *Structures.* Rostrum reaching posterior third of mesosterno. *Genitalia. Genital capsule.* Posteroventral edge entire, with small and opened "U" concavity (Fig. 3). *Parameres.* Figures 1–2.

Measurements. Length head: 1.12; width across eyes: 1.80; interocular space: 0.76; interocellar space: 0.18; length antennal segments: I, 4.92; II, 3.68; III, 2.72; IV, 4.96. Pronotal length: 2.44; width across frontal angles: 1.28; width across humeral angles: 3.24. Scutellar length: 1.60; width: 1.28. Total body length: 12.46.

Female. *Color.* Similar to male. Connexival segments VIII and IX bright orange; abdominal segments VIII and IX dark red with bright orange reflections; genital segments yellow. *Measurements.* Length head: 1.24; width across eyes: 2.00; interocular space: 0.84; interocellar space: 0.24; length antennal segments: I, 5.28; II, 4.00; III, 2.96; IV, 4.80. Pronotal length: 2.84; width across frontal angles: 1.44; width across humeral angles: 4.12. Scutellar length: 1.84; width: 1.72. Total body length: 14.[illegible].

Variation. 1—Head dorsally bright yellow with hazel diffused marks. 2—Antennal segments I to III bright orange. 3—Abdominal sterna yellow with a median longitudinal stripe bright hazel, running from the III to VII sterna. 4—Genital plates of female yellow with posterior margin hazel.

Holotype male. PAPUA NEW GUINEA: GOILALA (Loloipa): Owen Stanley Range, 1-15.II.58. W.W. Brandt. Deposited in BPBM.

Paratypes. PAPUA NEW GUINEA: GOILALA (Loloipa): Owen Stanley Range, 1-

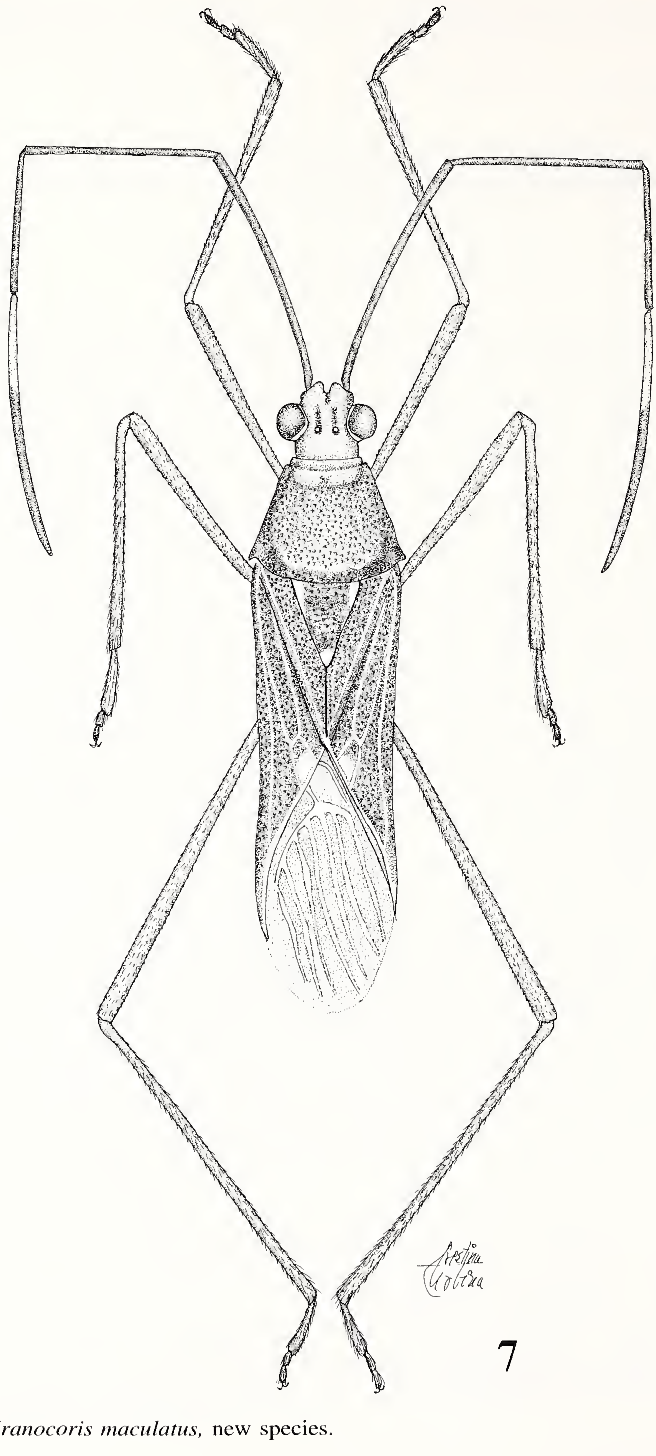


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Fig. 7. *Uranocoris maculatus,* new species.

15.II.58. W.W. Brandt. One female. Deposited in BPBM. PAPUA NEW GUINEA: Wau, 16.I.?. One female. Deposited in BPBM. PAPUA NEW GUINEA: NE: Port Moresby to Brown River (30 mts.) 29.X-1.XI.65. J. Sedlacek. One female. Deposited in BPBM. PAPUA NEW GUINEA: GOILALA (Tapini): Owen Stanley Range (975 mts.), 16-25.XI.57. W.W. Brandt. Two males, one female. Deposited in BPBM and IBUNAM. PAPUA NEW GUINEA: SE: Brown River (5 mts.), 23.X.60. J.L. Gressitt. Two males, one female. Deposited in BPBM and IBUNAM. PAPUA NEW GUINEA: NE: Bulolo (700 mts.), 26.XI.69. Two females. Deposited in QMBA and IBUNAM. PAPUA NEW GUINEA: NE: Bulolo (850 mts.), 29.VIII.65. One female. Deposited in QMBA.

Discussion. This is a medium-sized species, similar in color and habitus to *U. suavis* Walker, the only previously known species of the genus. *U. maculatus* is easily distinguished by the pale yellow discoidal spot located on the inner third of the apical margin of the corium (absent in *U. suavis*), the shape of the parameres (Figs. 1–2, 4–5), and the general view of the posteroventral edge of the male genital capsule (Figs. 3, 6).

Etymology: The specific epithet of the species refers to the pale yellow discoidal spot of the corium.

Distribution. Known only from the type locality, New Guinea.

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AN UNUSUAL NEW SPECIES OF *BARYSCAPUS* FÖRSTER (HYMENOPTERA: EULOPHIDAE: TETRASTICHINAE) FROM NORTH AMERICA

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Abstract.—*Baryscapus megos*, a new species of tetrastichine Eulophidae, is described and illustrated. This species is unusual in having a very large mouth opening. A key is presented to separate it from other species of North American Tetrastichinae with such a large mouth.

LaSalle (1994) provided a key to North American genera of Tetrastichinae which included a single genus (and species) with an enlarged mouth opening, *Exastichus odontos* LaSalle. An additional species of Tetrastichinae with a large mouth opening, *Kocaagizus pirireisi* Doğanlar was described from North America by Doğanlar (1993). This genus was not included in LaSalle's key, however it was briefly discussed in a note added while in press (LaSalle, 1994).

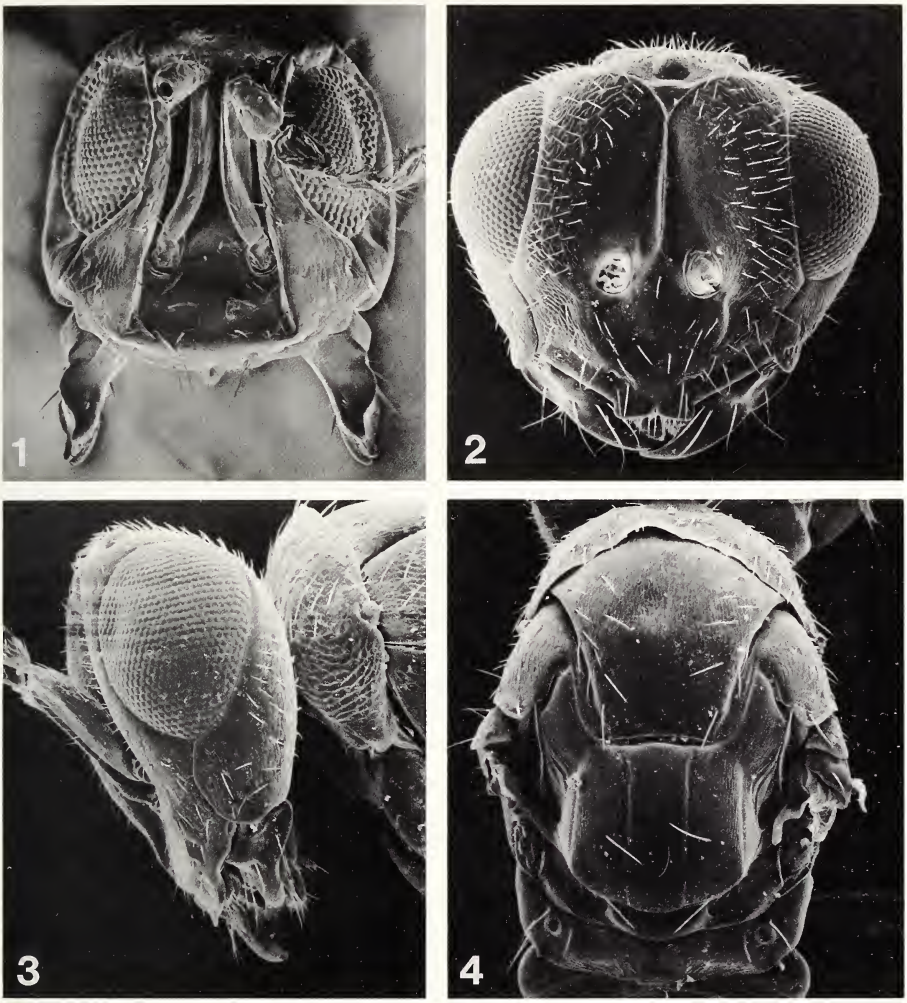
Baryscapus megos n. sp. is the third species of North American Tetrastichinae known to have an enlarged mouth opening, and the first species of the genus *Baryscapus.* This description is necessary because current generic keys for North American Tetrastichinae will have to be slightly modified to accommodate this new species.

Morphological terminology follows Graham (1987) and LaSalle (1994). Abbreviations for Museums are as follows: BMNH—The Natural History Museum, London, UK; CNC—Canadian National Collection of Insects and Arachnids, Ottawa, Ontario, Canada; IARI—National Pusa Collection of Insects, Indian Agricultural Research Institute, New Delhi, 110012, INDIA; UCR—University of California, Riverside, California, USA; USNM—The U.S. National Museum of Natural History, Smithsonian Institution, Washington, D.C., USA.

Baryscapus megos, new species
(Figs. 2–7)

Diagnosis. Mouth opening broad, 3.0–3.5 times wider than malar space (Fig. 2); clypeus produced into two large lobes; mandible large. Malar groove curved. Mesoscutum with 6–12 adnotaular setae, in more than a single row. Median groove on mesoscutum distinct. Callus with 4 setae. Submarginal vein with 2 setae.

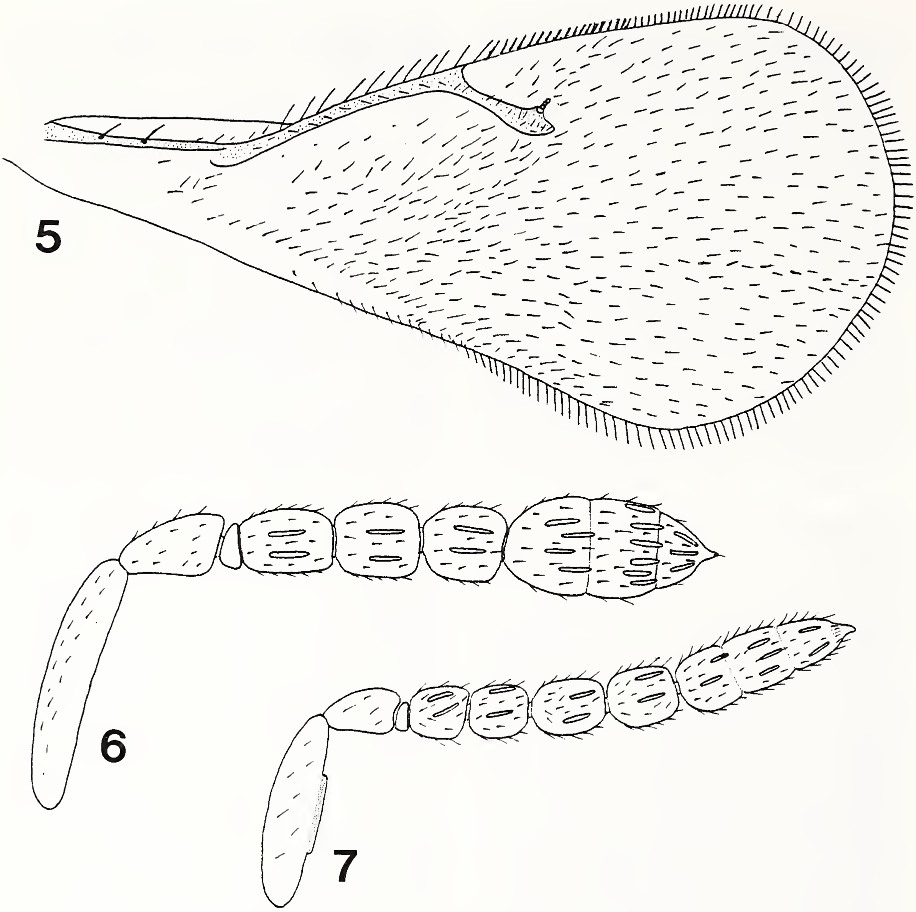
Female. Length to apex of last tergite 1.4–1.75 mm. Head, mesosoma and gaster ranging from dull metallic blue to brown with metallic blue shine, the mesosoma dorsally more distinctly metallic than other parts. Lower face with yellow streak below torulus; ventral margin of face and clypeus yellow to brown; mandible brownish yellow; antenna yellowish brown. Coxae and femora brown; apex of femora,



Figs. 1–4. 1. *Exastichus odontos* LaSalle ♀, face. 2–4. *Baryscapus megos* n. sp. ♀: 2, head, frontal view; 3, head, side view; 4, mesosoma, dorsal view.

tibiae and tarsi pale yellow; tibiae may be slightly darkened. Wing veins pale yellow, setae brown. Setae on face, antenna and body yellow.

Head (Figs. 2–3) 1.05–1.15 times broader than high in facial view. Malar groove curved, malar space about 0.38–0.45 eye height. Distance between posterior ocelli about twice as long as distance from posterior ocellus to eye margin. Clypeus distinctly produced, incised medially, with two large lobes. Mouth opening 3.0–3.5 times as wide as malar space. Antennal toruli at lower level of eye margin. Side of face with many minute punctures. Mandible large, bidentate, the ventral tooth distinctly longer than dorsal tooth.



Figs. 5–7. *Baryscapus megos* n. sp.: 5, ♀ forewing; 6, ♀ antenna; 7, ♂ antenna.

Antenna (Fig. 6) with scape 4.5–5.5 times as long as wide. Antenna with one anellus. Funicular segments subequal in width; F1 1.3–1.4 times, F2 1.1–1.25 times, F3 1.1–1.2 times as long as wide. Club 2.0–2.2 times as long as than wide

Mesosoma (Fig. 4) finely sculptured. Midlobe of mesoscutum with 6–12 adnotaular setae, these somewhat scattered and forming more than a single, straight row. Median groove on mesoscutum distinct. Scutellum 1.1–1.2 times as wide as long. Dorsellum slightly convex. Propodeum with median carina mostly eliminated; with faint paraspiracular carina. Callus with four setae.

Forewing (Fig. 5) with 2 setae on dorsal surface of submarginal vein. Marginal vein 0.70–0.80 times as long as costal cell, 1.75–1.85 times as long as stigmal vein.

Gaster 1.25–1.35 times as long as mesosoma, and 1.4–1.6 times as long as wide. Lateral sides of all tergites pubescent. Ovipositor sheaths short.

Male. Length 1.15–1.6 mm. Similar to female in coloration and morphological fea-

tures except in sexual characters. Scape (Fig. 7) with ventral sensory plaque 0.40–0.45 total length of scape, situated near center of scape. F1 and F2 1.1–1.2 times; F3 and F4 1.1–1.25 times as long as wide. Club 3.0–3.1 times as long as wide. Funicular segments with short, sparse setae; without a distinct basal whorl of long dark setae.

Material examined. Holotype ♀, USA, Arizona, Pima, Co., 4 mi.S.Robles Junction, 26.viii.1979, C. W. Melton (USNM).

59♀, 6♂ paratypes. Same data of holotype (or collected by J. LaSalle) (20♀, 2♂ USNM; 10♀1♂: UCR, BMNH, CNC; 5♀1♂ LaSalle; 4♀ IARI).

Discussion

Baryscapus is the second largest genus of Tetrastichinae in the Holarctic region, with 43 North America species (LaSalle, 1994) and 57 European species (Graham, 1991). It can generally be distinguished from other tetrastichine genera by the following characters: submarginal vein with 2 to many setae on dorsal surface; at least the longest two of the cercal setae subequal in length, relatively short and often not conspicuous in their difference from the setae on the surrounding tergites of the metasoma; propodeal spiracle with entire rim exposed; body dark or metallic, without pale or yellow markings; mesosternum generally convex in front of trochantinal lobe, without a distinct precoxal suture; malar sulcus often strongly curved. *Baryscapus* is included in keys to Tetrastichinae genera for Europe (Graham, 1987, as *Eutetrastichus*; 1991) and North America (LaSalle, 1994).

Within *Baryscapus, B. megos* is easily distinguished by the presence of a mouth opening that is three or more times as wide as the malar space. All other Holarctic species have the mouth opening less (usually distinctly less) than twice as wide as the malar space.

There are now three species of North American Tetrastichinae which have enlarged mouth openings (mouth opening three or more times as wide as malar space). Only one of these genera, *Exastichus*, was included by LaSalle (1994) in his key to North American genera. These species may be separated using the following key couplets. These would best be included in LaSalle's (1994) key at couplet 44, where *Exastichus* is distinguished.

Key to North American Tetrastichinae with enlarged mouth openings

1. Mandibles exodont (curving outwards), and not meeting medially (Fig. 1) . . . . *Exastichus odontos* LaSalle
   Mandibles normal, curving inwards and when closed meeting or overlapping medially (Fig. 2) 2
2. Propodeum with a raised lobe of the callus which partially overhangs spiracle. Malar sulcus straight or only slightly curved. Female antenna with 4 funicular segments (the first smaller than the second) . . . . *Kocaagizus pirireisi* Doğanlar
   Propodeum with entire spiracular rim visible (Fig. 4). Malar sulcus distinctly curved (Fig. 3). Female antenna with 3 funicular segments (Fig. 6) . . . *Baryscapus megos* n. sp.

Acknowledgments

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this study were kindly provided by the Department of Entomology, The Natural History Museum, London; technical assistance from the SEM and photography units of the BMNH is also gratefully acknowledged. This publication was partially funded through NSF grant BSR-9020206 (JL).

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NEW NAMES AND OTHER TAXONOMIC CHANGES IN THE ORIENTAL MEMBRACIDAE (HOMOPTERA: MEMBRACOIDEA)

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Abstract.—Nine new replacement names are proposed for species in the genera *Tricentrus, Oxyrhachis* and *Gargara. T. elongatus* Kato, *T. minullus* Jacobi, and *Centrotypus perakensis* Distant are reinstated as valid names. *T. mckameyei* Ahmad is emended as *T. mckameyi, T. strümpeli* Ahmad and Yasmeen as *T. struempeli,* and *Gargara dönitzae* Matsumura as *G. doenitzi. Kotogargara alini yunnanensis* Yuan and Chou is revised as *Gargara* (*Kotogargara*) *parvula yunnanensis* (Yuan and Chou), new combination. Fifteen new or reinstated species combinations in *Tricentrus* and *Gargara* are established to follow previous generic changes.

During the preparation of an updated taxonomic catalogue of world Membracoidea (by SHM) and a checklist of the Auchenorrhyncha found in China and adjacent regions (by APL), it became evident that a number of nomenclatorial changes in the family Membracidae were necessary. In this paper, we offer new replacement names for 9 homonyms, reinstate 3 valid specific names, emend 3 incorrect original specific spellings, revise the status of 1 subspecies, and propose 15 new or reinstated species combinations.

REPLACEMENT NAMES

Tricentrus dubitatus Liang and McKamey, **New Name**

Tricentrus dubius Ananthasubramanian, 1980a:25, pl. 24, figs. 1–6 (preoccupied by *Tricentrus dubius* Kato, 1960:348, fig. 1a–i).

Ananthasubramanian (1980a) described *Tricentrus dubius* from two males and three females collected in West Bengal, India. Because the name *T. dubius* is preoccupied, the replacement name *dubitatus* is here proposed.

Tricentrus taiwanensis Liang and McKamey, **New Name**

Arisangargara nitida Kato, 1928:48, pl. 1, fig. 8 (preoccupied by *Tricentrus nitidus* Funkhouser, 1927a:2, figs. 1–3).

Kato (1928) described *Arisangargara nitida* from an unspecified number of female specimens from Taiwan. Funkhouser (1943) transferred *nitida* from *Arisangargara* to *Centrotoscelus,* which he treated as synonyms. When Ahmad and Yasmeen (1974) synonymized both *Arisangargara* and *Centrotoscelus* with *Tricentrus, Arisangargara nitida* Kato 1928 implicitly became a junior secondary homonym of *Tricentrus*

nitidus Funkhouser 1927. We accept the placement of *nitidus* Kato in *Tricentrus* and propose the replacement name *T. taiwanensis* for it.

Tricentrus kodaikanalensis Liang and McKamey, **New Name**

Tricentrus purpureus Ananthasubramanian and Ananthakrishnan, 1975:230, fig. 26-1-9 (preoccupied by *Tricentrus purpureus* Funkhouser, 1942:62, pl. 7, fig. 2).

Ananthasubramanian and Ananthakrishnan (1975) described *Tricentrus purpureus* from nine males, sixteen females, and eight nymphs collected in Kodaikanal, Madras, India. Because the name *T. purpureus* is preoccupied, the replacement name *kodaikanalensis,* derived from the type locality of Ananthasubramanian and Ananthakrishnan's species, is here proposed.

Tricentrus nigritus Liang and McKamey, **New Name**

Tricentrus nigra [sic] Ahmad and Yasmeen, 1979b:265, figs. 19–21 (preoccupied by *Arisangargara nigra* Kato, 1928:48).

Ahmad and Yasmeen (1979b) described *Tricentrus niger* (as *T. nigra*) from a single female collected at Rangamati of Bengal. Upon synonymizing both *Arisangargara* and *Centrotoscelus* with *Tricentrus* (Ahmad and Yasmeen, 1974:183), *Tricentrus niger* Ahmad and Yasmeen implicitly became a junior secondary homonym of *Arisangargara nigra* Kato 1928. We accept the placement of *T. niger* (Kato), new combination, and propose the replacement name *nigritus* for *T. niger* Ahmad and Yasmeen.

Tricentrus yasmeeni Liang and McKamey, **New Name**

Tricentrus matsumurai Yasmeen and Ahmad, 1976:108, figs. 24–26 (preoccupied by *Arisangargara matsumurai* Kato, 1928:50. Replacement name for *Centrotus* (*Gargara*) *variegatus* Matsumura, 1912:21 nec *Centrotus variegatus* Signoret *in* Fairmaire and Signoret, 1858:336).

Yasmeen and Ahmad (1976) described *Tricentrus matsumurai* from two females collected at Radjendra Gang of East Bengal. When Ahmad and Yasmeen (1974) synonymized *Arisangargara* and *Centrotoscelus* with *Tricentrus,* they implicitly transferred *A. matsumurai* Kato 1928 into the latter genus. We accept the placement of *T. matsumurai* (Kato), new combination, and propose the replacement name *T. yasmeeni* for *T. matsumurai* Yasmeen and Ahmad 1976.

Oxyrhachis ampliata Liang and McKamey, **New Name**

Oxyrhachis grandis Ananthasubramanian, 1980a:7, pl. 7 (preoccupied by *Oxyrhachis grandis* Capener, 1962:97, pl. 22, fig. 50).

The new replacement name is Latin for enlarged or widened, to resemble the meaning connoted by the former name.

Oxyrhachis bulla Liang and McKamey, **New Name**

Oxyrhachis tuberculata Ananthasubramanian, 1980b:113, figs. 1–3 (preoccupied by *Oxyrhachis tuberculata* Walker, 1858:109).

Ananthasubramanian's name is a primary homonym of Walker's, which was returned to the genus *Oxyrhachis,* from *Xiphistes,* by Capener (1962:33). The new name, similar in meaning to the former, is Latin for a knob, to describe the distinct tubercle on the pronotum.

Oxyrhachis monochroma Liang and McKamey, **New Name**

Oxyrhachis unicolor Ananthasubramanian, 1980a:8, pl. 8 (preoccupied by *Oxyrhachis unicolor* Walker, 1851:509).

Ananthasubramanian's name is a primary homonym of Walker's, which was, like the previous species, formerly in the genus *Xiphistes,* but returned to *Oxyrhachis* by Capener (1962:161) when he synonymized these genera. The new name for the junior homonym is Greek but was chosen to preserve the meaning of the Latin name it replaces.

Gargara aliquantula Liang and McKamey, **New Name**

Gargara minuscula Ananthasubramanian, 1978:291 [preoccupied by *G. minuscula* (Walker, 1870:191)].

Ananthasubramanian's name is a primary homonym of Walker's, which was formerly placed in the genus *Centrotus,* but transferred to *Gargara* by Distant (1915: 492). The new name for the junior homonym is Latin for little, to resemble the meaning connoted by the former name.

OTHER TAXONOMIC CHANGES

Tricentrus elongatus Kato, **Reinstated Name**

Tricentrus elongatus Kato, 1929:540, pl. 16, fig. 3a, b.
Tricentrus gracilis Kato, 1930:287; unjustified emendation of *T. elongatus* Kato, 1929.

Although Kato's (1930) correction of his original spelling for the species was accepted by Metcalf and Wade (1965), the correction contravenes ICZN Art. 32b. Because the change was demonstrably intentional, the subsequent spelling is an emendation with its own availability (Art. 33b, International Commission on Zoological Nomenclature 1985 [ICZN]). Nevertheless, the original spelling cannot be taken as incorrect (Art. 32c) and the emendation is therefore unjustified. The emendation implicitly became a secondary junior homonym of *Arisangargara gracilis* Kato, 1928, when Ahmad and Yasmeen (1974) synonymized *Arisangargara* with *Tricentrus,* but the homonym is not replaced because it is rejected as a junior synonym (Art. 60a).

Tricentrus minullus Jacobi, **Reinstated Name**

Tricentrus minullus Jacobi, 1944:33 [new name for *Tricentrus minor* Lindberg *in* Lindberg and Zachwatkin, 1936:4, figs. 1c, 2c (preoccupied by *Otaris minor* Schmidt, 1911:243)].

Jacobi (1944) proposed *Tricentrus minullus* to replace *T. minor* Lindberg 1936,

which was a secondary junior homonym of *Otaris minor* Schmidt 1911. However, Metcalf and Wade (1965:401) reinstated *T. minor* Lindberg as a valid name and listed *T. minullus* Jacobi as an unnecessary replacement name for (and objective synonym of) *T. minor* Lindberg. Because the secondary junior homonym *T. minor* Lindberg is permanently invalid (ICZN, Art. 59b), *T. minullus* Jacobi is here reinstated as a valid name. *T. minor* Lindberg is now again a junior homonym, but is not replaced because it is rejected as a junior synonym.

Centrotypus perakensis Distant, **Reinstated Name**

Centrotypus perakensis Distant, 1916:318 [new name for *C. alatus* Buckton, 1903: 237, pl. 54, figs. 2, 2a (preoccupied by *Hemiptycha alata* Fairmaire, 1846:317, pl. 6, fig. 24)].

Distant (1916) proposed *Centrotypus perakensis* to replace *C. alatus* Buckton 1903, which was a secondary junior homonym of *Hemiptycha alata* Fairmaire 1846. This was accepted by Funkhouser (1927b:377, 1951:255). However, Goding (1930, 1950) treated *C. alatus* as a valid species and listed *C. perakensis* Distant first (1930: 40) as a synonym and later (1950:127) as a *nomen nudum* under *alatus* Buckton. Metcalf and Wade (1965:195) followed Goding (1950), reinstated *C. alatus* Buckton as a valid name and listed *C. perakensis* Distant as an unnecessary replacement name for (and objective synonym of) *C. alatus* Buckton. Because the secondary junior homonym *C. alatus* Buckton is permanently invalid (ICZN, Art. 59b), *C. perakensis* Distant is here reinstated as the valid name for the species.

Tricentrus mckameyi Ahmad, **Emendation**

Tricentrus mckameyei Ahmad, 1992:209 [new name for *Tricentrus planicornis* Yasmeen and Ahmad, 1976:112, figs. 37–39 (preoccupied by *Tricentrus planicornis* Jacobi, 1944:33)].

Yasmeen and Ahmad (1976) described *Tricentrus planicornis* from a single female collected at Rangamati of East Bengal. Because the name *T. planicornis* is preoccupied, Ahmad (1992) proposed the replacement name *mckameyei,* said to be derived from the name of the junior author of this paper. Because Ahmad's (1992) original spelling *mckameyei* must therefore be taken as incorrect [ICZN, Art. 32c(ii)], it is here emended as *mckameyi.*

Tricentrus struempeli Ahmad and Yasmeen, **Emendation**

Tricentrus strümpeli Ahmad and Yasmeen, 1979a:547, figs. 66–72, 550, 555 [also spelled *strumpeli*].

Ahmad and Yasmeen (1979a) described *T. strümpeli* from five males taken at Punjab, Pakistan. We apply the principle of first revisor to fix the original spelling as *strümpeli,* which we emend to *struempeli* in accordance with IZCN Arts. 32c(iv, vi) and 32d(i) (2).

Gargara doenitzi Matsumura, **Emendation**

Centrotus (Gargara) dönitzae Matsumura, 1912:23.

Matsumura (1912) described *Centrotus (Gargara) dönitzae* from one male and one female from Honshu, Japan. The species was named after Herrn Dönitz. Since Matsumura's (1912) *dönitzae* can not be taken as a correct original spelling [ICZN, Art. 32c(ii, vi)], it is here emended as *doenitzi* [Art. 32d(i) (2)].

Gargara (Kotogargara) parvula yunnanensis (Yuan and Chou), **New Placement, New Combination**

Kotogargara alini yunnanensis Yuan and Chou *in* Yuan *et al.,* 1992:210 (Chinese), 219 (English), fig. 19.

Yuan and Chou (see Yuan et al., 1992) described *yunnanensis* as a new subspecies of *Kotogargara alini* (Funkhouser) from a single female collected at Lushui of Yunnan, southwestern China. *Kotogargara* Matsumura was reduced to a subgenus of *Gargara* Amyot and Serville and *K. alini* (Funkhouser) as a junior synonym of *Gargara (Kotogargara) parvula* Jacobi by Anufriev (1981:167). Here the subspecies *yunnanensis* Yuan and Chou is revised as a subspecies of *Gargara (Kotogargara) parvula.*

OTHER NEW OR REINSTATED COMBINATIONS

Ahmad and Yasmeen (1974) synonymized both *Arisangargara* and *Centrotoscelus* with *Tricentrus* and reinstated the synonymy of *Otaris* with *Tricentrus.* Anufriev (1981) reduced *Kotogargara* Matsumura to a subgenus of *Gargara* Amyot and Serville. However, the implied resultant combinations for many species in those junior synonymic genera have never been published. We accept the generic changes proposed by Ahmad and Yasmeen (1974) and Anufriev (1981). To improve nomenclatural and taxonomic stability, we here propose the following new or reinstated combinations inferred from those generic changes.

Tricentrus flavus (Kato), **New Combination**
Arisangargara flava Kato, 1928:50.

Tricentrus gracilis (Kato), **New Combination**
Arisangargara gracilis Kato, 1928:47, pl. 1, fig. 7.

Tricentrus handschini (Funkhouser), **New Combination**
Centrotoscelus handschini Funkhouser, 1936:196, fig. 6.

Tricentrus intermedius (Schmidt), **Reinstated Combination**
Otaris intermedius Schmidt, 1911:242.

Tricentrus luteus (Funkhouser), **New Combination**
Centrotoscelus luteus Funkhouser, 1918a:30.

Tricentrus maculipennis (Funkhouser), **New Combination**
Centrotoscelus maculipennis Funkhouser, 1933:579, fig. 1.

Tricentrus marginatus (Kato), **New Combination**
Arisangargara marginata Kato, 1928:49.

Tricentrus matsumurai (Kato), **New Combination**
Arisangargara matsumurai Kato, 1928:50.

Tricentrus minor (Schmidt), **Reinstated Combination**
Otaris minor Schmidt, 1911:243.

Tricentrus niger (Kato), **New Combination**
Arisangargara nigra Kato, 1928:48.

Tricentrus nigrifrons (Kato), **New Combination**
Arisangargara nigrifrons Kato, 1928:49.

Tricentrus porrectus Funkhouser, **Reinstated Combination**
Tricentrus porrectus Funkhouser, 1929:118, pl. 1, fig. 10.
Otaris porrecta (Funkhouser); Metcalf and Wade, 1965:423.

Tricentrus shinchikunus (Kato), **New Combination**
Gargara shinchikuna Kato, 1928:44.

Tricentrus truncaticornis Funkhouser, **Reinstated Combination**
Tricentrus truncaticornis Funkhouser, 1918b:8.
Otaris truncaticornis (Funkhouser); Metcalf and Wade, 1965:423.

Gargara (*Kotogargara*) *botelensis* (Matsumura), **New Combination**
Kotogargara botelensis Matsumura, 1938:153.

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EFFECTS OF DIET QUALITY AND QUEEN NUMBER ON GROWTH IN LEPTOTHORACINE ANT COLONIES (HYMENOPTERA: FORMICIDAE)

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Abstract.—Laboratory experiments manipulating the diet of colonies of the facultatively polygynous ant, *Leptothorax curvispinosus* (Mayr), demonstrated that carbohydrates and protein have synergistic effects on egg numbers and brood production in colonies of this ant. Colonies receiving insect prey and sucrose grew significantly faster than colonies reared on unlimited supplies of either of these food types alone. This study also measured the effect of queen number on colony growth rates. Because the occurrence of multiple queens might affect colony growth only under certain nutritional conditions, polygynous colonies were reared in each of the three diet treatments. Queen number did not affect colony worker production in any of the three diet treatments; thus, individual queens in polygynous colonies produced far fewer workers per queen than did queens in monogynous colonies. There were no interaction effects between queen number and diet on colony growth. Several colonies which lacked morphologically distinct queens produced workers over the course of the experiment. Using artificially established colonies of unmated workers, we found no evidence for parthenogenetic (thelytokous) reproduction in these colonies.

Key Words.—Formicidae, *Leptothorax,* diet, polygyny, brood development.

Production in social insect colonies generally consists of both a vegetative stage, during which new workers are added to colonies, and a sexual stage involving the release of males and females with the potential to mate. The rate of vegetative growth is determined mainly by workers that have foregone their own reproduction to devote energy to the growth of their siblings (Oster and Wilson, 1978). To date, only a few studies have examined the effect of diet on colony growth during this vegetative phase (Brian, 1973; Buschinger and Pfeifer, 1988; Porter, 1989). Buschinger and Pfeifer (1988) found increased larval and pupal production in colonies of *Leptothorax acervorum* fed insect prey and honey, when compared to those fed an artificial diet. They also found behavioral changes in these ants and in the slave-making species *Harpagoxenus sublaevis.* Porter (1989) demonstrated that a diet of insect prey and sucrose was optimal for colony growth in the imported fire ant, *Solenopsis invicta.* Colonies fed insect prey alone fared significantly better than those reared on sucrose alone. Colonies of *Myrmica rubra* reared on insect prey and a sucrose solution also were more productive than those not given insects (Brian, 1973).

The facultatively polygynous ant *L. curvispinosus* is an excellent subject for measuring colony growth and development under controlled circumstances, due to its

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small colony size and the ease with which it accepts artificial nests. Natural populations of these ants are composed of at least three kinds of nests: those having a single queen, those with two or more queens and those containing workers but no queens (Talbot, 1957; Herbers, 1984, 1986 for *L. longispinosus*). Therefore, one can measure the effects of queen number on growth in unmanipulated colonies.

This study had two initial goals. The first was to examine the effect of diet on the population dynamics of monogynous and polygynous colonies of *L. curvispinosus* by rearing them for 14 weeks on three different diets. Colonies were fed either insect prey alone (high protein diet), a sucrose solution (high carbohydrate diet), or both. The second was to observe whether the effect of queen number was the same in colonies reared on the different diets. Eggs, larvae, and workers were censused weekly to determine diet and queen effects on all life stages.

A substantial fraction of nests in the field contained no distinct queen. Eggs and larvae were present in these nests, suggesting either worker reproduction or egg laying by queens in neighboring nests of the same colony. We reared eight colonies which lacked a morphologically distinct queen on the high protein-high carbohydrate diet. Over a period of four months, members of three of these colonies laid eggs that developed into new workers. To determine whether these workers arose via parthenogenesis (thelytoky) from unmated workers, we established and monitored nests of newly eclosed (unmated) workers.

METHODS

Colonies of *L. curvispinosus* were collected from acorns (*Quercus rubra*) in a wooded area on the northeast corner of the Princeton University campus, Princeton, New Jersey. Whole, intact acorns are impenetrable for the ants and they usually rely on acorn weevils (Curculionidae) to make the nuts habitable (Talbot, 1957). These weevils develop within fallen acorns, feeding on the fruit and finally drilling a small exit hole after eclosion. Acorns with holes indicating the emergence of curculionid beetles were taken in dark canisters to the laboratory, where they were examined for ants. Acorns having these characteristic openings usually contained colonies of *L. curvispinosus*.

Ants were placed into individual arenas consisting of clear plastic boxes (11 × 11 × 4 cm) with lids. Fluon (Northern Chemical Co., Woonsocket, R.I.) was applied to the container walls to prevent ants from escaping. Artificial nests were placed into each arena. Nests consisted of two glass microscope slides (2.5 × 7.5 cm) separated by a 1.0 mm wide piece of cardboard cut to form a rectangular cavity between the slides. A single entrance hole was cut along the walls of this cardboard spacer, and a layer of red cellophane was placed between the cardboard and the top slide to reduce light in the nest cavity, while allowing colony observation. Colonies usually moved into the artificial nests within ten hours of being placed into the arena. They were maintained at a temperature of 25°C, on a 16L:8D light cycle.

Following collection, queenright colonies were divided by queen number. Thirty six monogynous colonies were divided into three groups of twelve. Similarly, 15 two-queened colonies were divided into three groups of five. For each queen class, one group received the high protein diet, another received the high carbohydrate diet and a third group was given both. Colonies of similar size were randomized before

Table 1. Egg, larva and worker numbers from initial census, October 30, 1987.

	No queen (N = 12)		One queen (N = 32)		Polygynous (N = 19)	
	$\bar{x}$	(SE)	$\bar{x}$	(SE)	$\bar{x}$	(SE)
Eggs	10.33	(5.08)	21.84	(5.59)	32.68	(5.22)
Larvae	25.75	(5.91)	25.84	(3.57)	38.00	(6.48)
Workers	43.58	(7.66)	46.38	(5.38)	63.95	(10.64)

being placed into the three diet treatments, so that mean colony size was equal across treatments.

Colonies receiving the carbohydrate diet were fed a solution of 10% sucrose. This was dispensed through a capped 1.5 ml. micro-centrifuge tube with a 3–4 cm long (0.25 mm diameter) capillary tube inserted through the side wall. To prevent pressure locks, small holes were made in the caps of the microcentrifuge. Colonies not receiving sucrose were given identical feeders filled with distilled water. All colonies were also provided water via micro-centrifuge tubes capped at one end with cotton. Sucrose solutions and water were replaced throughout the experiment as needed. In the high protein diets, adult fruit flies (*Drosophila melanogaster*) were given to the colonies *ad libitum.* All flies were killed by freezing before feeding them to the ants, as a moving stimulus was not necessary to induce attack by *Leptothorax* workers. Uneaten flies were replaced with fresh flies every two days.

Production of brood and workers within each colony was estimated by taking weekly standing counts. For the censuses, nests were removed from their arenas, and eggs, larvae and workers were counted using a binocular microscope.

We compared the final counts of eggs and larvae using a two-way analysis of covariance (ANCOVA), with diet and queen number as factors and colony size (worker number) as the covariate. Change in worker number was also compared using an ANCOVA, with queen and diet classes as factors and initial worker number as the covariate. In both cases, interactions between queen number and diet effects were also examined. Six of the smaller monogynous colonies went extinct during the experiment and one colony lost its queen in the second week. These seven colonies were excluded from the analysis of worker production.

Colonies of unmated workers were established by periodically harvesting pupae from several productive queenright colonies. When these pupae eclosed, colonies were reared on a diet of *Drosophila* and a 10% sucrose solution. They were maintained at constant temperature (25°C) for five months, then were kept at approximately 4°C for three months, before being returned to room temperature.

RESULTS

Field collections. Table 1 presents the population structure for 63 queenless, monogynous and polygynous colonies. Twelve (19%) of the acorns had no morphologically distinct queen. Thirty-two (51%) had one queen, while nineteen (30%) were polygynous. Three additional colonies collected with this sample consisted of *L. curvispinosus* workers enslaved by queens and workers of the slave-making ant, *Protomognathus americanus.* These colonies were excluded from the experiment.

In the first census, egg presence appeared to be positively correlated with queen

number, although these differences are not significant when confounding effects of colony size are removed (ANCOVA, $P = 0.244$). Eight of the twelve queenless colonies lacked eggs, as did eleven of the thirty-two single-queen colonies. All polygynous colonies had eggs present.

All colonies, including those without queens, contained larvae. These larvae were predominantly early instars and no pre-pupae nor pupae were present. No male or female sexuals were found in any of the colonies censused. From their colony composition, we assume that these colonies were preparing to diapause for the winter. Typically, colonies of *L. curvispinosus* require a period of vernalization before recommencing healthy brood production. However, in the following growth experiments, colonies resumed growth in the laboratory without overwintering. This suggests that, at least in certain parts of its range, *L. curvispinosus* does not have an obligate vernalization requirement.

Standing egg counts. Beginning by the fourth week, colony egg numbers showed the effects of their diets, as shown in Figure 1a. Colonies receiving flies only and those fed sucrose only had similar increases in egg numbers during the experiment, while those receiving both flies and sugar showed a much greater increase. By the end of the experiment, the effects of these three diet treatments were significant (Table 2). Monogynous and polygynous colonies had similar egg numbers throughout the experiment. When analyzed individually, none of the diet treatments showed any effect of multiple queens on egg numbers.

Standing larva counts. As was the case for eggs, larval numbers were highest in the combined fly and sugar treatment. Interestingly, larval numbers were higher in the sugar-only than in the flies-only treatment (ANCOVA, $P < 0.01$). As with the data from egg numbers, queen number did not significantly affect the count totals, and there were no interaction effects between queen number and diet. As shown in Table 2, final larval numbers depended significantly on worker number from the first census.

Production of workers. Worker numbers diverged between the three diet treatments beginning around week 10 (Fig. 1b). These differences occurred six weeks after the egg numbers had begun to show significant differences, giving a rough representation of the development time for workers under these diet and temperature conditions. Production of workers was significantly higher in colonies receiving both flies and sugar than in those receiving flies or sugar alone (Fig. 1b, Table 2). Queen number did not influence worker production in any of the three diet groups (Table 2). Initial colony size was also a poor predictor of colony growth.

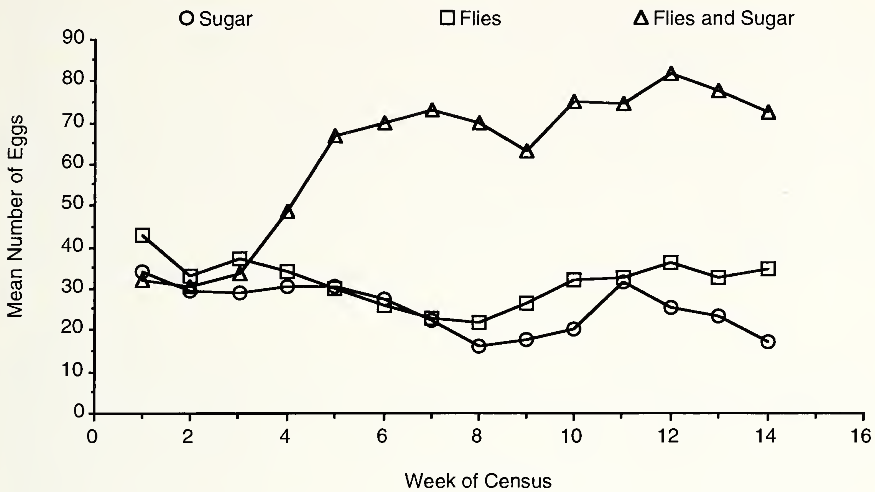
Production in queenless colonies. Of the eight apparently queenless field colonies, six increased in worker number over the course of the experiment (Table 3). In three of these colonies, the increase in worker number was greater than the combined total of eggs and larvae present initially. In 11 artificial colonies consisting of unmated workers, no new workers were produced. Males were produced in each of these colonies, suggesting that laboratory conditions were sufficient for brood development.

DISCUSSION

Diet effects

Diet quality had a strong effect on both egg and larva numbers and overall worker production of these *Leptothorax* colonies. Sucrose (carbohydrate) and insect prey

a)



b)

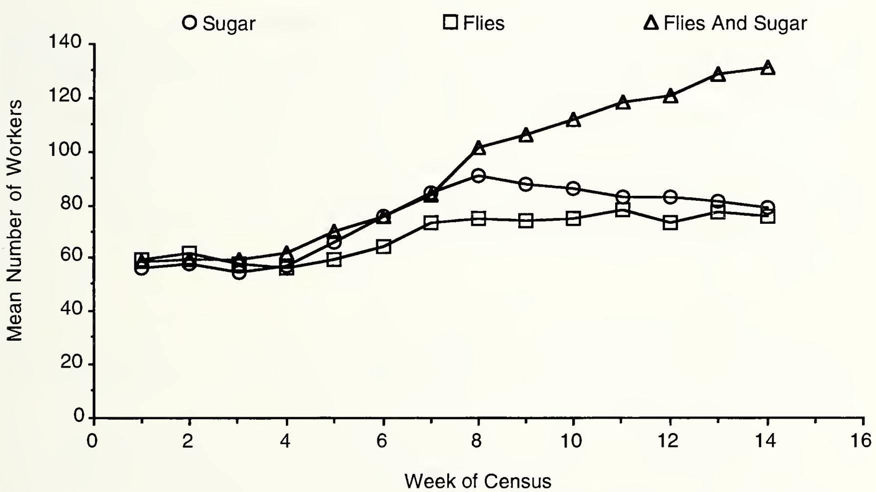


Fig. 1. a) Weekly egg numbers during the experiment for monogynous and polygynous colonies given three different diets. b) Weekly worker numbers during the experiment for monogynous and polygynous colonies given three different diets.

Table 2. ANCOVA results for brood and worker production in experimental colonies. Worker number was used as a covariate against diet and queen number. Egg and larva counts, and worker production, were strongly dependent on diet class. Larva numbers were also positively associated with worker number. * $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$.

			F ratio (Prob > F)		
Source of effect	Nparm	DF	Eggs	Larvae	Worker increase
Diet	2	2	6.00 (0.005)**	9.22 (0.0005)***	7.15 (0.0022)**
Queen number	1	1	0.154 (0.697)	0.0046 (0.946)	0.031 (0.860)
Diet × queen number	1	1	0.058 (0.943)	0.554 (0.579)	1.396 (0.244)
Worker number	2	2	0.021 (0.885)	6.58 (0.014)*	0.237 (0.790)

(largely protein) clearly have synergistic effects on egg numbers and subsequent colony growth, as colonies given both grew far more quickly than those raised on an unlimited supply of one or the other. Because a diet of insect prey provides all the nutrients needed for growth, it is surprising that colonies given insect prey alone did as poorly as those fed only sucrose. In contrast, Porter (1989) found that colonies of *Solenopsis invicta* reared on crickets alone grew substantially faster than those given sucrose alone. Other studies (e.g., Buschinger and Pfeifer, 1988; Tschinkel, 1988) also suggest that protein availability is the main determinant of colony growth. It is possible that these colonies of *L. curvispinosus* rely to a larger extent on energy derived from carbohydrates, than do other species.

The data on egg numbers do not provide information about actual egg-laying rates: rather they are a record of the fraction of eggs at each census that has survived oophagy, and it is possible that oophagy varied among the treatments. Brian (1957) found high rates of oophagy by first instar larvae in colonies of *Myrmica rubra.* Assuming that egg hatching time was constant for all treatments, these counts provide an accurate measure of the relative number of potential offspring among the treatments. Accordingly, differences in egg numbers were correlated with the actual worker production of colonies raised on the three diets (corr. coefficient, $r = 0.336$, $P < 0.05$).

Table 3. Census results for eight queenless colonies, taken over 18 weeks. * = Colony produced more workers than the number of initial brood. > = Colony worker numbers increased at some point during experiment.

	11/20/1987				1/2/1988				4/2/1988			
Colony	Eggs	Larvae	Workers	Total	Eggs	Larvae	Workers	Total	Eggs	Larvae	Workers	Total
1*	3	11	48	62	91	31	59	181	97	115	79	291
2*	17	6	31	54	30	41	31	102	—	62	68	130
3*	21	9	23	53	—	104	23	127	33	60	64	157
4>	—	4	4	8	—	4	4	8	—	3	5	8
5>	—	24	37	61	—	20	40	60	—	18	36	54
6>	22	4	21	47	7	15	26	48	1	6	34	41
7	17	9	4	30	2	21	2	25	—	7	1	8
8	28	12	54	94	94	29	51	174	7	29	38	74

Queen effects

The laboratory experiment suggests that queen number does not strongly affect colony growth. If we assume that each queen in a polygynous nest lays roughly the same number of eggs as every other queen in that nest, then the individual fecundity of queens in terms of worker production appears to be substantially reduced by polygyny. These results are consistent with those collected by Wilson (1974) for *L. curvispinosus* colonies monitored over the course of one month. Elmes (1973) found that, while the standing crop of eggs in field colonies of *Myrmica rubra* increased with queen number, the number of larvae, hence colony growth, varied only with the number of workers. He predicted that colony growth in *M. rubra* reflects mainly the amount of food taken in, not the number of queens in a nest.

Further behavioral studies are needed to determine whether the reduction in per-queen productivity is due to inhibition among queens (as shown for *Solenopsis invicta* by Vargo, 1992) or to limits imposed by the size of the worker force. Bourke (1993) found no evidence for such inhibition in *Leptothorax acervorum.* Behavioral and genetic analyses also would help to determine whether the "costs" of polygyny are shared equally within the nest. For example, in polygynous colonies of the imported fire ant, *Solenopsis invicta,* particular queens appear to dominate sexual production (Ross, 1988).

Various colony-level advantages from polygyny are possible. Members of polygynous colonies might benefit from a higher survivorship rate of these colonies as opposed to monogynous colonies. In fact, in the course of this experiment, 7 of the monogynous colonies went extinct, while all of the polygynous colonies survived. While this result may be confounded by differences in worker number, there was overlap in colony size between some of the monogynous colonies that went extinct and the smallest polygynous colonies.

Another explanation for polygyny in ants is an increased ability to exploit newly available resources. For example, polygyny is present in some species of *Pseudomyrmex* inhabiting the hollow thorns of tropical *Acacia* trees. Janzen (1973) suggested that polygynous colonies are more efficient at providing eggs for their exponentially increasing *Acacia* nest sites. Although this has not been examined experimentally, these colonies may use polygyny as a method of displacing other, competing, colonies. Perhaps the similar tendency of *Leptothorax* colonies to bud off into new nests (Stuart, 1985; Herbers, 1986) has selected for the high degree of polygyny in these ants. As polygynous colonies spread to new trees or acorns, conflict among queens may be reduced. However, given that queen number had no effect on colony growth in our experiments for each diet regime, it appears that arguments of polygyny as strictly a means of rapid colony expansion are inadequate.

Polygyny in ants raises a series of important evolutionary and ecological questions. Further studies measuring the costs and benefits of polygyny should have at least two goals. First, production rates must be taken under a variety of dietary and environmental conditions. Second, other factors determining both colony and queen longevity under monogyny and polygyny should be examined. Empirical studies of sperm use and limitation by queens might explain in part the lower instantaneous production rates of queens in polygynous colonies, if monogynous queens are often

sperm limited. In addition, polygyny may be favored by other environmental factors which place a premium on colony survivorship (reviewed by Herbers, 1993).

Production in queenless colonies

The production of workers in queenless colonies remains enigmatic. We were unable to show diploid production in colonies with definitively unmated workers, suggesting that thelytoky is either rare or impossible among these ants. Dissections of workers in naturally queenless colonies, while showing a high frequency of ovarian development (20–40%), did not reveal the presence of spermathecae in the workers examined. While it is possible that queen-worker intermorphs occur in these ants (Passera, 1984), there was no evidence for a stepwise gradation in female size or morphology. This raises the possibility of two distinct castes of mated females; one consisting of winged queens and the other of apterous, mated workers (e.g., Peeters, 1991). Further cytological, genetic or behavior studies are needed to determine the mechanism by which apparently queenless colonies can produce workers in *L. curvispinosus.*

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BIOLOGICAL OBSERVATIONS ON *PHASIA ROBERTSONII* (TOWNSEND) (DIPTERA: TACHINIDAE), A NATIVE PARASITE OF ADULT PLANT BUGS (HEMIPTERA: MIRIDAE) FEEDING ON ALFALFA AND GRASSES

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Abstract.—*Phasia* larvae were found only in the adult stage of the mirid species examined. Only one species of *Phasia* was detected, *P. robertsonii* Townsend); this species has been known by several other names, but most publications refer to it as *Alophorella aeneoventris* (Williston). *P. robertsonii* was reared from six species of mirids (ranked by parasitism level): *Leptopterna dolabrata* (L.) (1.8%), *Lygus lineolaris* (Palisot) (0.6%), *Megaloceroea recticornis* (Geoffroy) (0.4%), *Stenotus binotatus* (F.) (0.2%), *Trigonotylus coelestialium* (Kirkaldy) (0.2%), and *Adelphocoris lineolatus* (Goeze) (0.1%). Five of these host records have not been reported before, and represent a wide variety of hosts—grass and legume feeders, univoltine to polyvoltine species, and immigrant as well as native mirids. The significance of this broad host range is discussed, including its relation to the low parasitism rates observed in this study and others. *P. robertsonii* had two generations per year in northwestern New Jersey, the first mainly in June and mostly on grass-feeding mirids, and the second exclusively on *Lygus* in October. No pupal diapause was detected, but parasite larvae may overwinter inside *Lygus* adults. The very low parasitism rates indicate that tachinids provide little or no population suppression of the six mirid species studied.

A multi-year field study of the parasites of mirid pests of alfalfa (Day et al., 1990, 1992) has shown that there are three kinds of parasites found in adult mirids—nematodes, braconids (Hymenoptera), and tachinids (Day, 1987). The braconids (*Peristenus* and *Leiophron* spp.) are much more abundant than the others, but braconids result from oviposition in mirid nymphs rather than in adults (Loan, 1974), and their presence in adults appears to be the result of poor synchrony (Day, unpubl.). It is not known if nematodes parasitize adult mirids, or whether the small percentages found in adults are, like the braconids, carryovers from the nymphal stage. On the other hand, tachinid larvae are found only in mirid adults (Day, unpubl.), so are an obligate parasite of this stage. Unfortunately, the literature contains almost nothing on the host range, degree of parasitism, and life cycles of tachinid parasites of mirids.

In addition, it appears that there are fundamental differences between the host relationships of the tachinids and the braconids that parasitize mirids. This paper will provide information on these subjects, and hopefully will stimulate others to conduct further research on tachinid parasites.

MATERIALS AND METHODS

Field collections. Beating net samples (usually 100 sweeps, occasionally 50) were taken from each of three alfalfa fields in northwestern New Jersey (Blairstown area, Warren and Sussex Counties). Sampling was at weekly intervals in spring and early

summer, and biweekly in late summer and early fall. Data from 11 years (1980–1990) are reported in this paper.

Mirid adults and nymphs were aspirated into separate styrene vials, food plant tips were added for sustenance, and ventilated caps were applied. Vials were promptly placed in an insulated cooler with freeze-packs, to minimize mortality.

Laboratory procedures. The numbers and species of the mirids were verified the next day in the laboratory, and most were placed in rearing cages with food (aliquots were frozen, for later dissection, to determine the amount of parasitism). Plant stems in vials of water were added as needed (usually twice weekly)—grass seed heads were used for grass-feeding species, and alfalfa tips for alfalfa-feeding mirids.

The ventilated styrene "Loan" cages (Loan and Holdaway, 1961) had a "false" screened bottom, to allow parasite larvae to quickly move down to the vermiculite pupation medium, avoiding possible predation by the mirids. The vermiculite was dampened every 3–5 days, and after 11 days, was removed to a small, separate, parasite emergence cage. This procedure was repeated for a second 11-day period, to recover any late-emerging parasites. Each emergence cage was held in an environmental chamber (25°C ± 1½°, 16 L:8 D photoperiod, 65% RH ± 10%) for three weeks. Cages were then moved to an outdoor insectary for the summer and fall, then to a refrigerator (2°C) for winter. In early spring, cages were returned to the environmental chamber, for emergence of diapausing parasites. The latter step proved necessary for the braconid parasites, but all tachinids emerged during the initial three-week period, prior to moving samples to the insectary.

After all parasite emergence had ceased, the vermiculite was carefully examined for parasite cocoons and puparia, to determine if mortality had occurred (if so, parasitism data were adjusted). However, few puparia without exit holes were found, indicating that tachinid mortality was low.

RESULTS AND DISCUSSION

Tachinid species. A total of 54 adult tachinids were reared during an eleven-year period, from 11,651 adult mirids. Just over half of the flies were determined, and only one species was detected, *Phasia robertsonii* (Townsend). This tachinid has been known by several different names (as will be discussed later), but most publications refer to it as *Alophorella aeneoventris* (Williston) (e.g., Arnaud, 1978; Stone et al., 1965).

Mirid hosts. The tarnished plant bug, *Lygus lineolaris* (Palisot) produced more *P. robertsonii* (Table 1) than did the other mirids. It is notable that *robertsonii* was reared from all six mirid species, and that five of the ten host associations in Table 1 are "new" (not found in recent literature, nor in the compilations by Arnaud, 1978; Herting, 1971; or Thompson, 1950, 1951). No doubt this lack of information is a result of the low parasitism rates by *P. robertsonii* (as will be discussed later), which makes them harder to detect, and of the small number of workers researching the parasitism of mirids in the field.

Host range. The broad host range (Table 1: original data, plus information from Arnaud 1978 for the three *Phasia* spp. now regarded as synonymns (Sun Xuekui pers. comm.) of *P. robertsonii* [*P. aeneoventris, P. fumosa* (Coquillett) and *P. pulveria* (Coquillett)] includes eight mirid species, a spittlebug (Cercopidae), and a

Table 1. Mirid hosts of *Phasia robertsonii* 1980–1990.

Hosts	Frequency[a]	New host record[b]
Lygus lineolaris (Palisot)	63%	
Leptopterna dolabrata (L.)	28%	+
Adelphocoris lineolatus (Goeze)	4%	+
Megaloceroea recticornis (Geoffroy)	2%	+
Stenotus binotatus (F.)	2%	+
Trigonotylus coelestialium (Kirkaldy)	2%	+

[a] Percentage of all parasites reared from each mirid host. This approximates the relative abundance in nature of *Phasia* from the different mirid species, and is a product of the number of each mirid collected (a result of the abundance and number of generations of each species) and the percentage parasitism (data in Table 2).

[b] Not previously reported in the literature. Additional hosts are recorded in Arnaud (1978) (parasite genus listed as *Alophorella*) for the following two species, which are now regarded as synonyms of *P. robertsonii* (Sun Xuekui: pers. corr.): *P. aeneoventris*: *Lygus hesperus* Knight (Miridae), *Cosmopepla bimaculata* (Thomas) (Pentatomidae), *Philaenus spumarius* (L.) (Cercopidae), and *P. fumosa*: *Lygocoris caryae* (Knight) (Miridae). I found four of the five reference sources given by Arnaud for these records (for all spp. except *L. caryae*) but only one provided incidence data (Clancy and Pierce, 1966: one tachinid from two years of collections of *L. hesperus*).

stinkbug (Pentatomidae). The six mirid hosts in the present study (Table 2) represent grass and legume feeders, univoltine and polyvoltine species, and immigrant as well as native origins. This "generalist" approach suggests that *P. robertsonii* is not likely to have a significant impact on any one species, as a "specialist" parasite might, and this is confirmed by the data in Table 2 (right column). The average parasitism of the most-preferred mirid, the meadow plant bug (*L. dolabrata*), was only 1.8%, hardly an indication of close adaptation, or "preference."

In a recent paper on British tachinids, Eggleton and Gaston (1992) pointed out that although tachinids are often thought of as dipteran equivalents of the endopar-

Table 2. Mirid biologies, and parasitism by *P. robertsonii* 1980–1990.

Mirid species[a]	Native	Host plant	Gener./yr.	No. reared: Hosts	No. reared: Para.	Mean parasitism[b]
1. *Leptopterna dolabrata* (L.)		grasses	1	832	15	1.80%
2. *Lygus lineolaris* (Palisot)	+	dicots	3	5,878	34	0.58%
3. *Megaloceroea recticornis* (Geoffroy)		grasses	1	242	1	0.41%
4. *Stenotus binotatus* (F.)		grasses	1	448	1	0.22%
5. *Trigonotylus coelestialium* (Kirkaldy)	+	grasses	3	466	1	0.21%
6. *Adelphocoris lineolatus* (Goeze)		legumes	3	3,785	2	0.05%
Totals				11,651	54	
Weighted average						0.46%

[a] Only the adult stage is parasitized by *Phasia*. A 7th species [*Halticus bractatus* (Say)] is occasionally numerous in alfalfa (Day and Saunders, 1990), but it is not listed here because no Diptera have been reared from it—probably because it is too small.

[b] Actual parasite impact is somewhat higher: peak rates are naturally larger than mean rates, and the rearing method underestimates parasite incidence (Day, 1994).

asitic ichneumonids (Hymenoptera), the tachinids usually have a much wider host range. They suggest that the breathing tube of tachinids allows this flexibility, because it reduces the need for immunity to host defensive blood cells, which can cover and thus suffocate hymenopterous parasites. Because these cells are likely to vary considerably from one host species to another, this physiological heterogeneity would make it very difficult for any single endoparasitic hymenopteran species to develop biochemical adaptations to many host species. Eggleton and Gaston reviewed host range data for 59 British tachinids, finding that 54% had five or more host species. It would be interesting to do a similar study on American tachinids—especially because Arnaud 1978 contains host data for nearly ten times more tachinid species (519).

Effects on mirids. The low parasitism rates in Table 2 indicate that *P. robertsonii* does not have a significant suppressive effect on any of the six mirid species, over all years. For comparison, parasitism of *L. lineolaris* nymphs by (mostly introduced) braconid parasites has ranged from 29% to 36% (Day et al., 1990).

Similar low rates of parasitism of mirid adults by tachinids have been reported by Medler (1961) in Wisconsin, Clancy and Pierce (1966) in California, Graham et al. (1986) in Arizona, and Sillings and Broersma (1974) in Indiana. Bilewiez-Pawinska (1977) did not report finding any tachinids in Polish mirids. A few have been found in France, by USDA European Parasite Laboratory personnel (unpubl. reports).

Life cycle and diapause. When the number of mirids parasitized by *P. robertsonii* that were collected each month were graphed (Fig. 1), several relationships became evident. There apparently were two generations per year, one in spring to early summer, and one in the fall. First generation parasites usually attacked the grass-feeding mirids, most of which are univoltine (probably to take advantage of the "flush" of grass growth that occurs in the spring). Although some overwintered (May and June) and first generation (July) tarnished plant bug adults were also attacked, the fall generation of *Phasia* parasitized the latter species exclusively.

All of the *Phasia* adults emerged from their puparia in the laboratory in the same year that they were collected. There was no evidence of a developmental pupal diapause, as is common in the braconid parasites of mirids when they are handled in the same way [hosts containing parasite eggs and larvae in various stages of development were collected from the field, then reared in the laboratory (Day et al., 1990, 1992)]. There are two possible means of overwintering: as soil temperatures drop in the fall, the development of *Phasia* puparia should slow, so most late fall puparia cannot complete their development and produce adult flies until soil temperatures warm in May. This is not as "fail-safe" as the obligatory overwintering diapause in the braconid parasites of mirids (which prevents emergence during warm winter periods) and might be another reason that tachinids are not abundant parasites of mirids. On the other hand, the broad host range of *P. robertsonii* allows use of many different plant bug species, so host-finding would rarely be a limiting factor. It is also possible that *Phasia* larvae may pass the winter inside one of their six host species (only *Lygus* overwinter in the adult stage), but the number of *Phasia* found in dissections of *Lygus* adults was too low to determine if this occurs (1 parasite larva found in 146 adults collected in May, and no parasites in 87 adults collected in October and November).

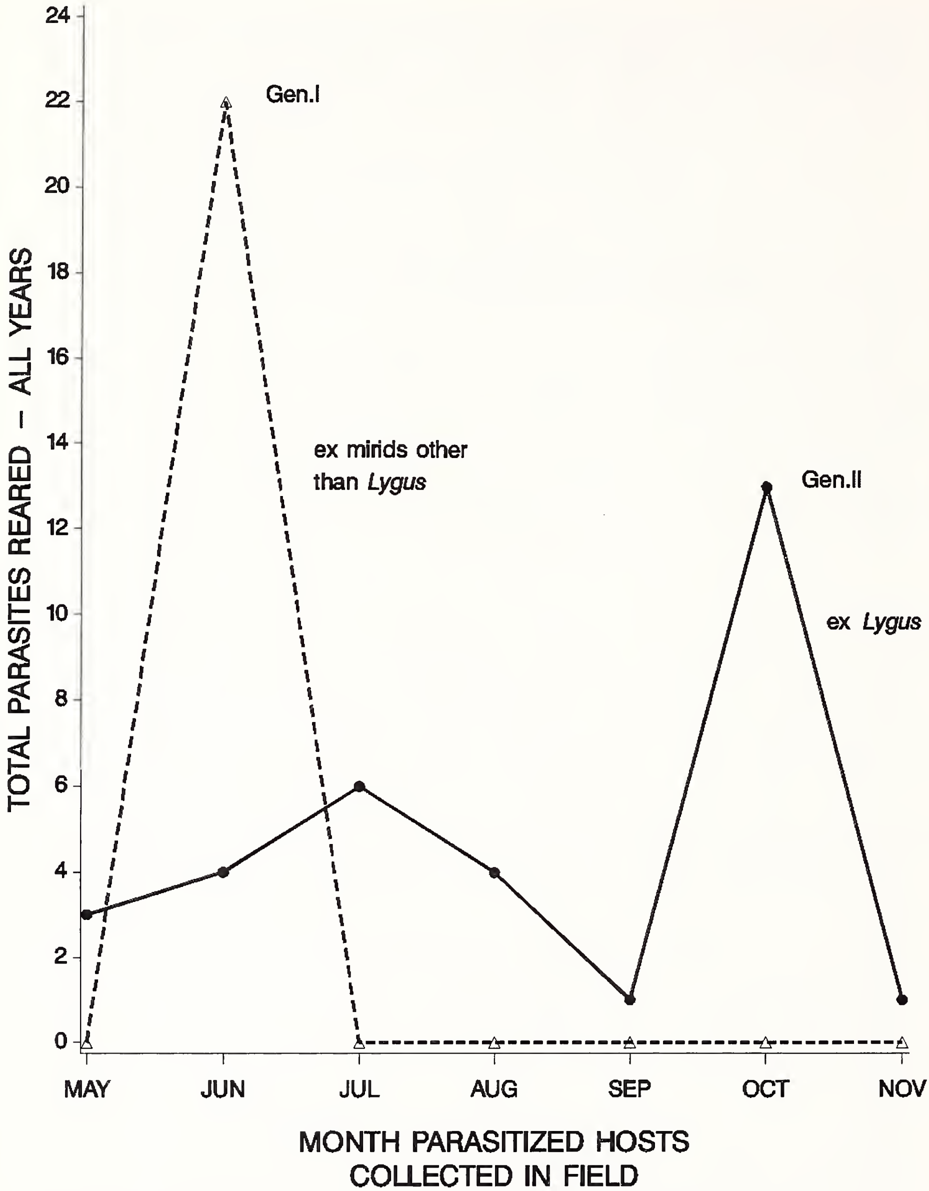

Fig. 1. Seasonal incidence of *P. robertsonii* reared from mirid adults, 1980–1990.

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AGISTEMUS EXSERTUS GONZALEZ (ACARI: STIGMAEIDAE) AS A PREDATOR OF CITRUS RED MITE (*PANONYCHUS CITRI* [MCGREGOR])

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Abstract.—The potential of using *Agistemus exsertus* to control *Panonychus citri* was studied in both laboratory and citrus grove. Functional response studies showed that *A. exsertus* adult females had the highest instantaneous rate of discovery (a = 1.430) and shortest handling time (Th = 1.67 hr) when provided with *P. citri* eggs as compared to other prey stages. In comparison with adults of both sexes, *A. exsertus* deutonymphs had the lowest a (0.102) and longest Th (4.32 hr) when *P. citri* eggs were provided as prey. *A. exsertus* females clearly exhibited a prey-stage preference; an average of 75.2% of prey consumption consisted of eggs as compared to 16.6 and 8.2% nymphs and adult males, respectively. The intrinsic rates of natural increase (rm) of *A. exsertus* were higher at 20 and 25°C, but lower at 30 and 35°C than that of *P. citri*. *A. exsertus* demonstrated a satisfactory control of *P. citri* in the greenhouse release study. Under natural conditions, the population of *A. exsertus* was very low in the winter and increased steadily from May through October.

Since mid 1930 more than 300 species of Stigmaeidae have been described (Sepasgosarian, 1985, 1990). The biology and predacious potential of the individual members of this family were not initiated until recent years (Elbadry et al., 1969a). Some species in the genera *Zetzellia, Agistemus,* and *Mediolata* were known to prey upon phytophagous mites of *Tetranychidae, Tenuipalpidae, Eriophyidae, Tydeidae,* and *Tarsonemidae* as well as some small insects (Tseng, 1982; Inoue and Tanaka, 1983; Ehara and Wongsiri, 1984; Clements and Harmsen 1990). Santos (1984) considered *Z. mali* (Ewing) to be the most significant nonphytoseiid predator of phytophagous mites. It was used as a regulating agent of *Panonychus ulmi* (Koch) and *Aculus schlechtendali* (Nalepa) in apple orchards (White and Laing, 1977). Childers and Enns (1975) reported that *A. fleschneri* Summer fed on all stages of tetranychid mites but preferred their eggs. In recent years, considerable research has been done to evaluate *A. exsertus* as a predator of such species as *Tetranychus cinnabarinus* (Boisduval), *T. arabicus* Attiah, *T. urticae* (Koch), *T. cucurbitacearum* (Sayed), *Eutetranychus orientalis* (Klein), *Aculops lycopersici* (Massee), *Eriophyes dioscoridis, Tenuipalpus granati,* and *Brevipalpus pulcher* (Afify et al., 1969; Elbadry et al. 1969a, b; El-Bagoury et al., 1989; Hafez et al., 1983; Hanna and Shereef, 1981; Rasmy et al. 1987). These studies demonstrated that *A. exsertus* could be used as an effective biocontrol agent for certain pest mites.

Citrus red mite, *Panonychus citri* (McGregor), is one of the most important citrus pests throughout the world, including China (He et al., 1989; Tan and Huang, 1989; Yue and Lei, 1990). Although many phytoseiid mites have been shown to be effec-

Table 1. Stages and numbers of citrus red mite used for feeding preference trials by *A. exsertus.*

Treatment	Egg	Larva and nymph	Adult male
1	40	10	5
2	10	40	5
3	5	10	40
4	30	10	15
5	10	30	15
6	15	40	30

tive predators of *P. citri,* their numbers were often very low in chemically treated citrus groves in China (Yue, unpubl.). *Agistemus exsertus* were more abundant than phytoseiids in some groves because *A. exsertus* were less affected by pesticides (Yue, unpubl.). This paper summarizes our study of *A. exsertus* as a biological control agent of *P. citri* under laboratory and field conditions.

MATERIALS AND METHODS

Study arena. A plastic foam pad (10 cm diam. × 1.5 cm deep) saturated with water was placed in a glass petri dish (12 cm diam. × 3 cm deep) and a 10 cm diam. filter paper was placed on top of the pad. Three mature pumelo leaves, *Citrus grandis* (L.) Osbeck, were placed on each filter paper with the lower leaf surface facing up. A water saturated absorbent cotton strip was placed along the outer edge of the each leaf to prevent the mites from escaping.

Predation study. Four life stages including eggs, larvae, nymphs and adult males of citrus red mite were used as prey at densities of 5, 10, 20, 30, 40, 50 and 60 per leaf arena with nine replicates for each treatment. One *A. exsertus* was transferred onto each arena. The number of prey consumed by each *A. exsertus* was recorded under a stereomicroscope every 12 hr over a 3-d period. Predation experiments with adult females, males, and nymphs of *A. exsertus* were conducted separately at 30°C in a growth chamber. The functional response parameters, including instantaneous rate of discovery (a) and handling time (Th) as defined by Holling (1959), were calculated.

Prey preference study. Pumelo leaf arenas were used for prey preference studies. *P. citri* adult females were transferred onto each arena for 24 hr to obtain eggs. Nymphs and adult males of *P. citri* were subsequently transferred. The numbers for each mite stage in each arena varied with six treatments (Table 1). There were three replications for each treatment. One *A. exsertus* adult female was placed onto each arena and the numbers of prey consumed by each predator was recorded once a day. The tests were conducted for three days at 27°C in a growth chamber.

Life table data. Recently matured leaves of sweet orange, *Citrus sinensis* Osbeck (L.), were used to rear citrus red mite. Each leaf was divided into two arenas by placing an absorbent cotton strip perpendicularly across the midrib. One newly emerged larva was transferred onto each arena using a fine brush under a stereomicroscope. Sixty larvae were reared at each of 15, 20, 25, 30 and 35°C. Survivorship and the number of eggs laid by each female were recorded once a day until

Table 2. The functional response parameters of *A. exsertus* to *P. citri* at 30°C.

Predator	Prey	Instantaneous rate of discovery (a)	Handling time (hr) (Th)
Female	Egg	1.430	1.67
Female	Nymph	0.335	4.66
Female	Male	0.172	2.29
Male	Egg	0.227	1.16
Nymph	Egg	0.102	4.32

death of female. *A. exsertus* was also reared at the same temperatures on sweet orange leaf arenas infested with citrus red mite eggs. Intrinsic rates of natural increase (rm), as defined by Birch (1948), were calculated using the life table data of both species.

Release experiment and field investigation. Four potted sweet orange plants, each with only 20 selected leaves, were used for release experiments in the greenhouse at 25 ± 2°C. Citrus red mite and *A. exsertus* reared in the laboratory were used for the release experiments. One hundred newly emerged adult females of citrus red mite were transferred onto each potted plant with a fine brush. Ten young adult females of *A. exsertus* were transferred onto each of two of the four citrus plants. The other two plants were served as controls. Observations were made every four days using a 10× hand lens and the numbers of motile stages of both prey and predator were recorded for a period of 35 days.

The field study was carried out bi-weekly in a sweet orange (*C. sinensis*) grove. Eighty leaves were collected randomly on each sampling date, and the leaf samples were observed under a stereomicroscope in the laboratory. *A. exsertus, P. citri,* and *Eotetranychus kankitus* Ehara, as well as all phytoseiids, were recorded. The bi-weekly samplings were taken over a period of ten months.

A study of the age composition of *P. citri* in the field was conducted in the winter (January and February) and spring (April and May). Five sweet orange trees were sampled weekly, and 20 leaves were collected randomly from each tree. The adults, immatures, and eggs were recorded.

RESULTS

Agistemus exsertus preyed upon eggs and other motile stages of *P. citri. A. exsertus* adult females had the higher instantaneous rate of discovery (a = 1.430) and shorter handling time (Th = 1.67 hr) when provided with *P. citri* eggs as compared to other prey stages (Table 2). On the other hand adult males of this predator had the shorter handling time (Th = 1.16 hr) and lower instantaneous rate of discovery (a = 0.227) than that of adult females. In comparison with the adults of both sexes, *A. exsertus* deutonymph had the lowest instantaneous rate of discovery (a = 0.102) and longest handling time (Th = 4.32 hr) when citrus red mite eggs were provided as prey (Table 2). *A. exsertus* clearly exhibited a prey preference when eggs, nymphs, and adult males of *P. citri* were provided as preys in same arena. It was found that an average of 75.2% of prey consumed by *A. exsertus* adult females were mite eggs as compared to consumption of only 16.6 and 8.2% by nymphs and adult males,

Table 3. Life stages of *P. citri* and *E. kankitus* preferred by *A. exsertus* adult females.

Life stage	Percentage in total prey consumption	
	P. citri	*E. kankitus*
Adult male	8.2	6.8
Nymph	16.6	18.9
Egg	75.2	74.3

respectively (Table 3). Under natural conditions, the number of citrus red mite eggs was consistantly found to be higher than the other life stages in spring and winter months (Table 4).

The intrinsic rates of natural increase (rm) for both prey (*P. citri*) and predator (*A. exsertus*) at five constant temperatures are given in Table 5. At 15°C, the rm values for both prey and predator were similar. *A. exsertus* had a slightly higher rm at 20 and 25°C than that of *P. citri.* In contrast, at 30 and 35°C the rm values for *P. citri* were higher than the values of *A. exsertus* (Table 5).

Figure 1 shows the results of release experiment on potted plants. The number of citrus red mite reached a total of 475 after 17 days followed by a sharp decrease as *A. exsertus* increased. The number of *A. exsertus* was recorded at 110 on the 24th day and this was eight days after the peak of prey population. The number of citrus red mite on the control plants increased slowly during the first 12 days and then increased rapidly, reaching 830 on the 28th day.

In winter months (Dec., Jan. and Feb.) the population levels of *A. exsertus* and *P. citri* were very low (Fig. 2). *A. exsertus* were found always in association with *E. kankitus.* The population of *P. citri* increased quickly in April and May and disappeared after June (Fig. 2). The dramatic increases of *A. exsertus* were observed from May to October when they coincided with the increase of another natural prey, *E. kankitus* (Fig. 2).

DISCUSSION

We have observed that *A. exsertus* preyed upon various life stages of *P. citri.* However, it clearly preferred to feed on citrus red mite eggs. When fed with citrus red mite eggs, *A. exsertus* had a shorter development time, longer longevity and higher reproductive rate than when they were fed on other immature stages (Hanna and Shereef, 1981; Hafez et al., 1983; Osman and Zaki, 1986; El-Bagoury et al.,

Table 4. The age composition (%) of citrus red mite in spring and winter months.

Time	Egg	Larva and nymph	Adult
April, 1987	60.51	29.62	9.87
May, 1987	53.08	36.18	10.74
Jan, 1988	65.77	27.63	6.60
Feb, 1988	62.31	31.39	6.30
Jan, 1989	73.69	19.24	7.07
Feb, 1989	80.58	15.42	4.00

Table 5. Comparison of intrinsic rate of natural increase (rm) for *P. citri* and *A. exsertus*.

Temperature (°C)	*P. citri*	*A. exsertus*
15	0.071	0.070
20	0.154	0.165
25	0.196	0.229
30	0.256	0.211
35	0.248	0.226

1989). Under field conditions, we noted that citrus red mite eggs were always more abundant than its immature and adult stages. Our study showed that eggs accounted for 61% and 53% of the total *P. citri* populations in April and May, respectively, and remained at 62–81% from January to February (Table 4). Therefore it is reasonable to assume that preying on the eggs is an advantageous strategy for *A. exsertus* as this predator is not as agile as phytoseiids.

Because of its life-stage preference *A. exsertus* can coexist with phytoseiids in the same habitat. We have found that citrus red mite in unsprayed groves was controlled by both *A. exsertus* and phytoseiids (Yue, unpubl.). We have also noted that *A. exsertus* was always more abundant than phytoseiids, especially in late summer and fall in the chemically treated groves because this predator is more tolerant to pesticides (Yue, unpubl.). The results showed that the efficiency of prey consumed by *A. exsertus* was dependent on the life stages of prey and predator as well as environmental temperature. In laboratory tests, one adult female of *A. exsertus* consumed as many as 12 citrus red mite eggs per day. The results of our greenhouse release

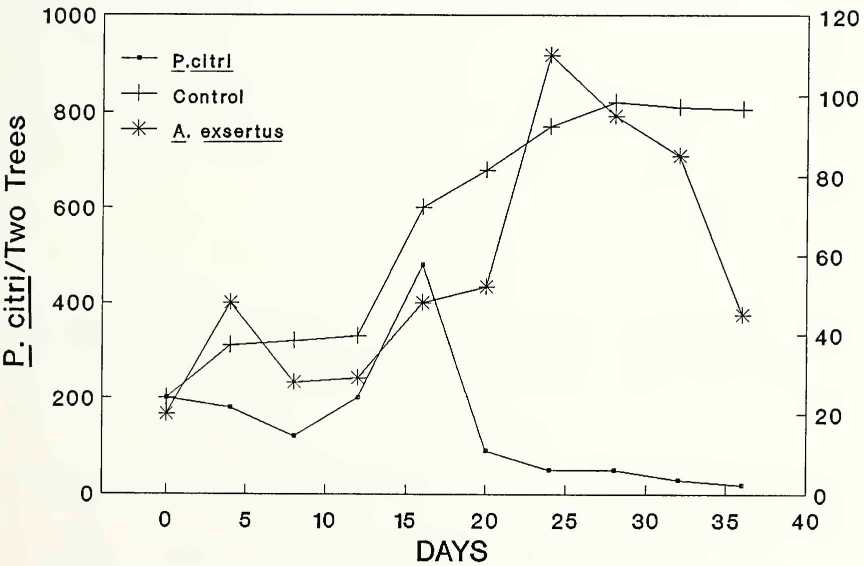

Fig. 1. Control of *Panonychus citri* by *Agistemus exertus* on potted citrus plants.

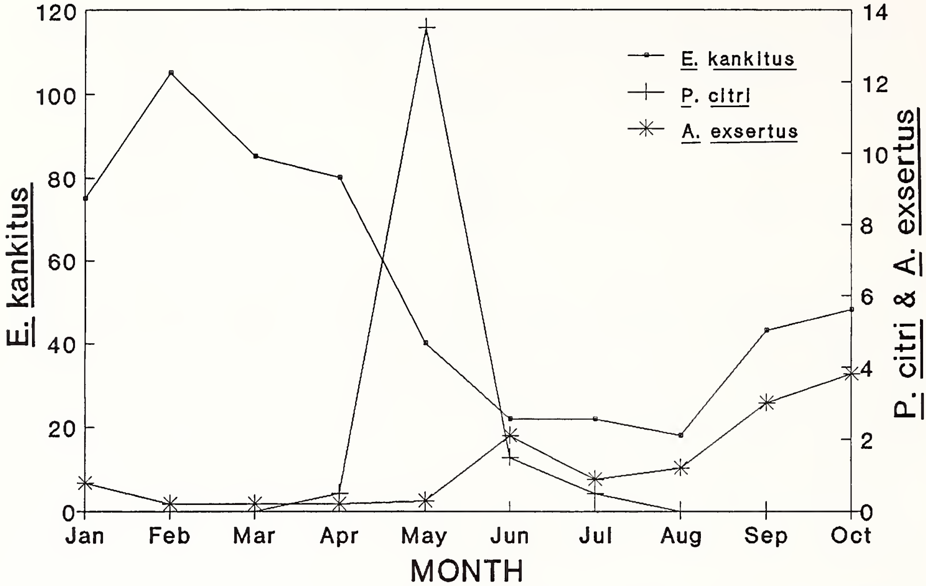

Fig. 2. Population dynamics of *Agistemus exertus* and its prey *Panonychus citri* and *Eotetranychus kankitus* in citrus grove.

experiment showed that citrus red mite was controlled after 20 days with a prey–predator ratio of 10:1 (Fig. 1). In citrus groves, citrus red mite populations built up very quickly in late spring and early summer. *A. exsertus* alone probably would not control citrus red mite. However, *A. exsertus* could play an important role in controlling the citrus red mite along with phytoseiids and other natural enemies. In the spring and winter months, the citrus red mite was mostly found to be at the egg stage which is a preferred food for *A. exsertus*. Therefore, *A. exsertus* could exert a great pressure on the prey population. In summary, we fell that *A. exsertus* can be used as a biocontrol agent for controlling the citrus red mite in conjunction with other predators in an integrated pest management program.

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A NEW KATYDID FOR LONG ISLAND, NY: FIRST RECORD OF *ORCHELIMUM SILVATICUM* EAST OF OHIO, WITH NOTES ON TWO ADVENTIVE KATYDIDS FROM LONG ISLAND

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Abstract.—A population of *Orchelimum silvaticum* (Tettigoniidae: Conocephalinae), previously unknown east of Ohio, was discovered on Long Island, Suffolk Co., NY. Available information on disjunct distributions for the entire genus *Orchelimum* is briefly summarized and discussed. Information on the history and current status of two introduced katydids previously reported from Long Island is also summarized.

In this note, I report the discovery of a population of *Orchelimum silvaticum* on Long Island, NY, some 700 km east of its previously known distribution, and discuss the significance of disjunct distributions of *Orchelimum* species. In addition, I report on the status on Long Island of two adventive katydids, *Metrioptera roeselii* and *Meconema thalassinum.*

ORCHELIMUM SILVATICUM

Orchelimum silvaticum[1] was described by McNeill in 1891. The synonymy of *O. silvaticum* with *O. calcaratum* (Rehn and Hebard, 1915; Blatchley, 1920) was established by Hebard (1934). In an important paper on the North American genus *Orchelimum,* Morris and Walker (1976) included maps (based on published records, museum specimens, recorded songs, and personal observations) showing the known distributions of all 18 *Orchelimum* species found north of Mexico (two additional species are known from Mexico). Based on 102 site records for *O. silvaticum,* they presented a distribution extending from South Dakota south to Texas and east to Ohio, Kentucky, Tennessee, and Alabama.

On 27 August 1990, while driving just east of Middle Island, Suffolk Co., NY, I heard what sounded like a weak *Orchelimum* song. Upon stopping to investigate, I realized there were many singers in the trees along the roadside and recognized the song as that of *O. silvaticum.* I collected three males and confirmed this identification. Returning to this site on 21 September and 14 October 1990 and 3 October 1992, I collected a total of 12 additional adult males (an adult female collected as she crossed the road later escaped). Three specimens have been deposited in the Florida State Collection of Arthropods. On a visit to the site on 6 October 1993 I heard only a few singers and collected no specimens. This is the only known site for *O. silvaticum* east of Ohio. In preliminary surveys of several similar sites in

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[1] The specific epithet "*silvaticum*" was incorrectly spelled "*sylvaticum*" once by Blatchley (1920) and consistently by Morris and Walker (1976).

central Suffolk Co. in 1992 and 1993, I was unable to locate any additional populations.

O. silvaticum is a semiarboreal member of a genus almost entirely associated with herbaceous vegetation, usually in or around fresh water (Morris and Walker, 1976; pers. obs.). At the Middle Island site, a roadside at the edge of a pitch pine-oak-heath woodland typical of the area (Reschke, 1990), singers were generally found in trees 2 m or more above the ground, although some were singing closer to the ground from tall herbaceous plants (e.g., *Oenothera* sp.).

The Middle Island site almost surely represents a dramatic disjunct. Given the relatively high quality of our knowledge of *Orchelimum* distributions (see below), it is very unlikely that this population simply represents the eastern limit of a poorly known continuous distribution. Indeed, apparently disjunct distributions have been documented for at least six other *Orchelimum* species (see Morris and Walker, 1976): (1) *O. concinnum* occurs nearly continuously along the Atlantic and Gulf Coasts, as well as in widely scattered populations in Indiana, southern Michigan, and western Ohio. This distribution may be the result of colonization of the Great Lakes region and subsequent relictualization in marl bogs in the early post-Wisconsin. Similar distributions have been described for a variety of plants and animals (Thomas, 1933, 1951; Reznicek, 1994). (2) *O. delicatum* is found in a broad north-south band across the central U.S. and in scattered populations extending eastward along the southern edge of the Great Lakes to Buffalo, NY (the "Prairie Peninsula," Transeau, 1935; Smith, 1957), with apparently disjunct populations in southeastern Louisiana, New Mexico, Arizona, and California (Thomas and Alexander, 1962; Morris and Walker, 1976; T. J. Walker, 1994 in litt.). (3) *O. volantum* has a fairly broad distribution in the Midwest, but has otherwise been collected only along the Delaware River in New Jersey (Fox, 1921, 1928; Morris and Walker, 1976). (4) *O. nigripes* is abundant in the Midwest and the western portion of the deep South, but is known east of the Appalachians only from the Potomac River basin in the Washington, D.C. area, where it has apparently replaced its putative sister species, *O. pulchellum,* during this century (Morris and Walker, 1976; Shapiro, in prep.), and from two single specimens collected in 1964 and 1993 in Amherst, MA (which may or may not represent an established population). In addition, I have examined three *nigripes* specimens, and Dr. T. J. Walker has examined at least two others, collected at Tappahannock, VA in 1913 (although five specimens collected at Tappahannock in 1915 and 1916 are clearly *pulchellum*). As of this writing, no extant *nigripes* population has been located at Tappahannock, although *pulchellum* occurs here in abundance. (5) *O. carinatum* has been collected in Tennessee, Louisiana, and extreme western Florida (probably a more or less continuous distribution), with additional records known only from Virginia. (6) *O. bullatum* is known only from Texas and Louisiana (many sites) and from single sites in Indiana and Missouri.

For some of these species, additional fieldwork may reveal apparent range disjunctions to be artifacts of ignorance (compounded by the tendency for even locally abundant and widespread *Orchelimum* species to occur in more or less discrete colonies). However, some of these disjunctions are undoubtedly real. *Orchelimum* katydids are unusually cooperative survey subjects in that they sing loudly and relentlessly in late summer and early fall, allowing a knowledgeable observer to quickly sample prospective collecting sites by simply walking and listening for a few min-

utes. In the early decades of this century, and again in the 1960s and 1970s, several orthopterists actively collected (and, in later years, recorded on tape) *Orchelimum* from around the eastern U.S. Thus, although the distribution maps provided by Morris and Walker are surely incomplete, they are probably close approximations to reality.

Orchelimum katydids are relatively weak fliers and most species (*O. silvaticum* and several others excepted) are closely associated with water. Thus, aside from movement along river drainages, opportunities for long distance dispersal are probably limited. Individuals (generally males, whether because of sampling bias or actual differences in dispersal behavior between the sexes) are occasionally found far from any suitable habitat, indicating the potential to travel long distances. However, the only way such long-distance dispersal can have a lasting effect on population structure or species distribution is by dispersal of already mated females, or by simultaneous dispersal of individuals of both sexes, which then find each other and mate. A further requirement for such dispersal to have any effect beyond the year in which it occurs, of course, is that a dispersed, mated female must find an appropriate place in which to leave eggs before the onset of winter. These events are probably quite infrequent. Nevertheless, given sufficient time such rare events could result in stepping stone range extensions, which could lead in turn to dramatically disjunct distributions following subsequent extinctions of some intervening populations, perhaps as lakes and ponds disappear. Some disjuncts (e.g., western *O. delicatum*) may represent relicts of once extensive distributions that were fragmented by climatic changes during the Pleistocene (Vickery, 1989). Allozyme work currently underway as part of a study of hybridization between *O. nigripes* and *O. pulchellum* (Shapiro, in prep.), as well as analyses of mtDNA from multiple populations (to be initiated presently), may provide some insight into population structure and patterns of gene flow in *Orchelimum* species (see, e.g., Avise, 1994).

In speculating on the origin of Long Island *O. silvaticum,* it is essential to consider the geological history of Long Island. Long Island was completely covered by ice during the Wisconsin stage of the Pleistocene glaciation, and deciduous forest was not established until about 9,000 years ago (Donner, 1964; Sirkin, 1977, 1994 pers. comm.). Thus, *O. silvaticum* must have reached Long Island some time within the last 9,000 years at most. The presence of *silvaticum* on Long Island may be the result of an inadvertent introduction by humans in the relatively recent past. There are no previous *silvaticum* records known from Long Island, nor from anywhere else in eastern North America. The type of habitat where the Long Island *silvaticum* were found is still fairly widespread on Long Island, and other kinds of habitat that are frequently utilized by *silvaticum* in the Midwest are also common on Long Island and the nearby mainland. Given these facts, a recent human introduction, perhaps eggs on nursery stock, seems to be the most likely explanation for the presence of *O. silvaticum* on Long Island. Of course, the possibility remains that the Long Island *silvaticum* are the result of dispersal from the Midwest or South (or from intervening populations, most or all of which have since disappeared) some time within the last 9,000 years.

A planned phylogenetic analysis of the genus *Orchelimum* across North America using mitochondrial DNA may shed light on the phylogeography of this group and help explain the intriguing distribution patterns we see today. By identifying the

historical relationships among populations and species, it may be possible to gain insight into the events leading to contemporary distributions.

METRIOPTERA ROESELII

In 1953, Urquhart and Beaudry published a note reporting the first North American records of the Palaearctic decticine *Metrioptera roeselii*[2]: seven specimens taken in 1952 at two sites in Québec, Canada, near Montreal. Noting that this species is common and widely distributed in Europe, they predicted that it would eventually extend its range over much of eastern North America. Kevan (1961), Kevan et al. (1962), and Vickery (1965) reported additional Québec records, including numerous macropterous individuals (generally quite uncommon in Europe) in addition to those already reported by Beaudry (1955). G. K. Morris (1994 in litt.) collected *M. roeselii* around Ithaca, NY, in 1965 and believes it was truly absent before then. In the mid-1960s he collected it at numerous sites in western and central New York (more recently, S. J. Scheffer collected several specimens at the E. N. Huyck Preserve near Albany in August, 1990). Morris also reports that westward moving *M. roeselii* reached Seeley's Bay, ON, in 1970 and Kingston, ON, around 1972. Vickery and Kerr (1974) reported numerous records for 1972–1974 of *M. roeselii* that had apparently spread north from New York via the Niagara Peninsula (i.e., around the western end of Lake Ontario). By 1975, *M. roeselii* had reached Kendal, ON, about 70 km east of Toronto, either from the east or via the Niagara Peninsula (G. K. Morris, 1994 in litt.). Ede (1974) reported records for 1971, 1972, and 1973 from Maine, Vermont, New Hampshire, and Massachusetts. Nickle (1984) reported what he believed to be the first record of *M. roeselii* from Pennsylvania, collected in 1982 in Wayne Co. in northeastern Pennsylvania. However, Morris (1994 in litt.) collected *M. roeselii* at several sites in Tioga Co. in northcentral Pennsylvania in 1965. I am aware of no published distribution records subsequent to Nickle's.

On 1 June 1990, I collected about a dozen nymphs of *M. roeselii* in an old field at the Brookhaven National Labs in Upton, Suffolk Co., NY, but no specimens were retained. On a return visit to the site on 26 June 1990, I found the field, and several adjacent fields, abuzz with the long, monotonous song of *M. roeselii.* One medium-winged adult male (wings reaching tip of abdomen) and one long-winged adult female (wings much surpassing abdomen) were collected, but no systematic survey of wing length in the population was attempted. On 29 June 1993, I revisited the site and collected 24 medium-winged adult males, one short-winged adult male (wings barely half length of abdomen), and three short-winged adult females. Three males have been deposited in the Florida State Collection of Arthropods. On 28 June 1994 two additional males were observed in an old field at Manorville (at least one of them long-winged) and on 29 June 1994 a male was observed at Stony Brook, both in Suffolk Co.. This species is apparently established on Long Island.

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[2] As noted by Marshall and Haes (1988), the specific epithet of this katydid should be written as *roeselii,* following Hagenbach's (1822) original description, although it is often written as *roeseli,* which would be linguistically correct.

MECONEMA THALASSINUM

In 1960, Gurney (1960a, b) reported the first North American records of the Palaearctic katydid *Meconema thalassinum:* six specimens collected at Little Neck in Nassau Co., NY, in 1957 and 1959. Johnstone (1970) reported one additional North American specimen, collected at King's Park, Suffolk Co., NY, in 1968. Sismondo (1978) reported taking multiple specimens (with the help of a colony of *Sphex ichneumoneus* in his driveway) at Scarsdale and Larchmont in Westchester Co., NY, from 1974 through 1977. Smith (1979) reported thirteen *M. thalassinum* collected at Garden City, Nassau Co., NY, in 1977. Most recently, Hoebeke (1981) reported single records from Ithaca, NY, and Middletown, RI, in 1974 and 1980, respectively.

On 24 July 1992, an adult female *M. thalassinum* was collected indoors at Port Jefferson Station, Suffolk Co., NY. On 5 August 1992, I collected two adult males at a porch light at night at Stony Brook, Suffolk Co., and collected an additional adult male from my car windshield on 7 August 1992 at Port Jefferson. One male has been deposited in the Florida State Collection of Arthropods. Individuals have also been observed at East Setauket (15 July 1993), at Nissequogue (6 July 1994), and on Shelter Island (11 July 1994), all in Suffolk Co.. *M. thalassinum* appears to be well established on Long Island.

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NOTES AND COMMENTS

J. New York Entomol. Soc. 103(1):121–122, 1995

AN ISOLATED POPULATION OF THE BOG ELFIN, *INCISALIA LANORAIEENSIS* SHEPPARD (LEPIDOPTERA: LYCAENIDAE), IN CENTRAL NEW YORK

The Bog Elfin, *Incisalia lanoraieensis* Sheppard, has heretofore been known in the United States only from Maine and New Hampshire, in acid *Sphagnum*-heath bogs (Opler and Krizek, 1984:101). Although the food plant, Black Spruce (*Picea mariana,* Pinaceae), is widespread in the northern United States and Canada (Collingwood and Brush, 1984:78–79), the distribution and biology of *I. lanoraieensis* remain poorly understood. Erhlich and Erhlich (1961:204) mentioned an "unverified" report of *I. lanoraieensis* from near Ithaca, New York; the specimen in question is now lost. Shapiro (1974:17), in his discussion of *I. niphon* (Hübner), described a series of smaller, "dull, dark" *I. niphon* from the Finger Lakes region of New York which may represent a separate species; he assigned Ehrlich and Ehrlich's report to this entity. No description of habitat was given. I report here confirmation that *I. lanoraieensis* occurs in New York State, for a State record, together with notes on range extensions of other butterflies in Onondaga County.

On 9 May 1986 I discovered a colony of *I. lanoraieensis* in the Cicero Swamp State Wildlife Management Area, Onondaga County, near Syracuse. The butterflies appeared to be restricted to a small area of mostly closed-canopy Black Spruce-Tamarack (*Larix laricina*)-Red Maple (*Acer rubrum*) peatland. Because of their small size and rapid, erratic flight, the butterflies would easily have been overlooked had they not descended from the tops of Black Spruce to alight on *Vaccinium* shrubs. Their preference for the forest canopy was noted also by Scott (1986:369), and A. B. Klots, who further pointed out that *I. lanoraieensis* comes down to feed in the morning hours, moving progressively higher as the day proceeds (pers. comm. to R. Dirig). One individual was observed palpating the buds of Red Maple. Four males and one female were collected; identification was confirmed at Ottawa by Ross A. Layberry (Kinburn, Ontario) and J. Donald Lafontaine (Biosystematics Research Centre, Agriculture Canada, Ottawa). One male specimen was deposited at the Cornell University Insect Collection (CUIC) by Robert Dirig (Ithaca). On 9 May 1988 one individual of *I. lanoraieensis* was observed at the site; close by in the open, brushy areas of the bog were *I. henrici* (Grote and Robinson), *I. niphon,* and *I. augustus* (W. Kirby). Since then, *I. lanoraieensis* has not been seen again, and its status is at present uncertain. A recurring potential threat is the repeated aerial spraying of insecticide over Cicero Swamp in mosquito abatement efforts. The nearest known Canadian population occurs in the Ottawa area (Hall et al., 1984). It is hoped that this example of a Pleistocene relict (Pielou, 1991) has not been inadvertently eliminated.

Other central New York records of interest include a range extension of *Pieris*

napi oleracea (Harris), perhaps temporary, and the permanent residence of both *Asterocampa celtis* (Boisduval and Leconte) and *A. clyton* (Boisduval and Leconte); these species were all taken at the Lafayette Experiment Station, Onondaga County, July 1985. *Oeneis jutta* (Hübner), recently discovered in Adirondack bogs (Klass and Dirig, 1992:25), may also occur at Cicero; any information on it and *I. lanoraieensis* in this regard would be appreciated. It is likely that *I. lanoraieensis* is much more widespread in upstate New York, especially in Adirondack bogs, but has been overlooked because of its canopy-dwelling habits. In this respect its obscurity may be analogous to that of another canopy-dwelling species, the Early Hairstreak, *Erora laeta* (W. H. Edwards) (Pyle, 1981:466). Another rare New York State butterfly, *Phyciodes batesii* (Reakirt), was last known from Onondaga County, but may now be extirpated; the probable last site of collection has been destroyed by commercial development.—*D. G. Miller III, Department of Environmental Science, Policy and Management, University of California, Berkeley, California 94720.*

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BOOK REVIEWS

J. New York Entomol. Soc. 103(1):123–125, 1995

Butterflies and Climate Change.—Roger L. H. Dennis. 1993. Manchester University Press, Manchester, U.K. 302 pp. Price.

This scholarly book offers a comprehensive review of our knowledge of British butterfly ecology, with particular reference to distribution and abundance correlated with extrinsic environmental variables. The book is encyclopedic and technical, providing summaries of major ecological studies of British butterflies and British weather, past, present and future. It is illustrated with 16 data tables and 40 journal-type figures. Perhaps its greatest asset is its tremendous bibliography, comprising 51 pages of citations, which I estimate to list nearly 1,000 publications. Dennis employs a dry, occasionally idiosyncratic writing style, and commands such a scope of material that the connections between themes and the crux of his argument are often submerged in detailed but tangential lacunae. This is especially so in the sections discussing the evolution of morphological and life-history attributes such as unpalatability, wing coloration and polyphenism. I cannot see the immediate relevance of Papageorgis' (1975) neotropical microhabitat stratification by mimicry groups to the proximate effects of rapid global warming on butterfly populations. The book has two additional deeply engrained flaws which I felt detracted from the general importance of its message: geographical provincialism and heavy reliance on correlation matrices for inferring causation. These criticisms will be elaborated after a brief chapter content summary.

Chapter One, "Atmospheric Systems and Butterfly Biology," begins with a review of mechanisms of weather and climate, then moves to a lengthy discussion of adult and larval thermoregulation in butterflies, and its relation with numerous life-history components (e.g., feeding, fecundity, avoidance of predators). Chapter Two, "Climate, Butterfly Populations and Distributions," spans a hierarchical range of topics, from individual life history strategies and phenology, through population ecology and demography, to patterns and determinants of geographical species diversity at the community level. Chapter Three, "Morphological Adaptations to Climatic Gradients," begins with an explication of wing pattern evolution and mimicry, then describes various gradients in morphological characters associated with climate, and ends with a discussion of seasonal polyphenism. Chapter Four, "Past Climates and Evolutionary History," combines knowledge of relatively recent (Pleistocene) climate change in Europe with hypothetical postdictions on butterfly distributions and diversification there. Chapter Five offers the promised, "Future Atmospheric Changes and Butterfly Populations: Predictions and Consequences," but focusses almost entirely on British species, and maintains a surprisingly depoliticized stance on human-induced effects and conservation issues.

Flaw 1: Provincialism.

This book should have been entitled, "British Butterflies and Climate Change." It contains 19 maps, all of Britain (three of which also illustrate Europe). The vast

preponderance of examples in the text are drawn from the palearctic fauna (87 of the 156 species listed in the index). There are two problems with this focus. First, I encountered my copy of this book on the "Environment" shelf of a university book store in New York. The back cover and preface offer no hint that it is primarily relevant only to British species. From a commercial perspective, it is clearly beneficial to market a book to the broadest possible customer base, but I find the neglect to mention Dennis' book's regional focus bordering on dishonesty. By contrast, E. B. Ford's (1990) "Butterflies" (also a deceptively vague title), states in the first sentence of both the author's and editor's prefaces that it is about British butterflies. Part of the motivation to downplay "Butterflies and Climate Change"'s provincial aspect may be the almost simultaneous publication (1992) of another book edited by Dennis, "The Ecology of Butterflies in Britain," which overlaps substantially in its subject matter with the current book.

We probably know more about the ecology of butterflies in Britain than those of anywhere else. Thus, the British emphasis in the book could be forgiven if the study of British butterflies and their ecology offered a plausible paradigm for understanding global climatic patterns and their effect on natural ecosystems. However, it is highly debatable whether this is the case. The British landscape has been so heavily trammelled by human activity for such a long time that any vestige of a "natural" baseline against which large-scale patterns of ecological change can be documented must have been thoroughly obliterated, if, indeed, a historical equilibrium state ever existed at all. The depauperate Palearctic fauna undoubtedly suffered far more from cooling during the Pleistocene than it has from global warming to date. Britain was largely covered with ice a mere 15,000 years ago, and most of its butterflies are recent immigrants from the continent: there are no endemic butterfly species, and few geographical races differentiated substantially from continental populations (of three recognized "British forms" (Ford 1990), *Papilio machaon britannicus* is rare and protected (Collins and Morris, 1985), while *Lycaena dispar dispar* has been extinct since 1848 (Higgins and Riley, 1970)). Ironically, Dennis (p. 214) predicts that "the majority of British butterflies will benefit from climatic change," a result counterintuitive to the notion that global warming is bad for biodiversity, but perhaps indicative of these species' relatively coarse degree of adaptation to their environment. In fact, contrary to the claim on the back of the book that "butterflies are particularly sensitive to climate and are important 'bioindicators' of climatic change," based on Dennis' conclusions, I suspect that speckled woods (*Pararge aegeria*) will still be flying in Oxfordshire when people are punting around East London in gondolas.

Flaw 2: Correlation vs. causation.

On p. 137, Dennis states:

> 'Correlation' and regression parameters are often not interpreted with sufficient caution, especially in multivariate designs (Vincent, 1981). Although a high (sic) significant correlation may confirm a hypothesis, it is not proof of the process modelled: other factors or links may have been omitted. Similar distribution changes in the past cannot simply be interpreted as having emanated from the same causes; equifinality is potentially rife in biotic systems. Conversely, low

> correlations are not proof of the absence of a relationship say between changes in heat and distribution changes.

This is a prudent statement reflecting appropriate concern for overconfidence in deterministic processes inferred from statistical relationships. Yet somehow, this message is lost throughout the rest of the book. Dennis repeatedly erects causal hypotheses and theories for butterfly distribution based on multiple regressions and correlations with abotic factors. The book contains several complex flow charts or ecological web diagrams illustrating arrays of interrelated abiotic parameters that may or may not play a role in the fate of particular butterfly species or of butterflies in general. These relationships are interpreted causally in the text:

> The multiple correlations of morph transformations with several climatic variables and the extensive covariance among the latter are expected because of their causal association in pressure systems . . . Thus it is plausible that there is a causal link between climate and population status with increasing latitude, an indirect one may exist between populaton parameters and phenetic transformations, as well as direct links between climate and phenetics. (p. 110)

Dennis follows the unfortunate reductionist tendency in the ecological literature to ascribe general (or average) observed patterns of diversity to universal, extrinsic processes. It strikes me that intrinsic, biotic attributes of individual species (e.g., larval foodplant distribution) rather than abiotic factors may be more directly linked to the survival of butterflies in particular environments, and that changes in butterfly distribution may be cascade effects of local community changes. Thus, while rapid, human-induced climate change is surely a dire environmental problem facing the planet, many species may be more immediately threatened by proximate problems such as habitat loss and competition with introduced flora, fauna and pathogens.—*Andrew V. Z. Brower, Dept. of Entomology, American Museum of Natural History, Central Park West at 79th Street, New York, New York 10024.*

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The Butterflies of the West Indies and South Florida.—David Spencer Smith, Lee D. Miller and Jacqueline Y. Miller. 1994. Oxford University Press, Oxford, New York, Tokyo. 264 pp. and 33 plates. $125.00 (cloth).

This is an authoritative guide to the 350 or so butterfly species occurring in the Greater and Lesser Antilles, Bahamas, and subtropical Florida, designed to replace Riley's (1975) field guide to the same region. The large format book gives detailed descriptions and accounts of life histories and distributions for all known species from the region, including nearly 60 new taxa described in the last twenty years. Almost all species and many differentiated subspecies from different islands are illustrated in detailed, life-sized color paintings by Richard Lewington (a few swallowtails are reduced). A taxonomic checklist, an extensive bibliography, and a good index are included. Plates and text are clearly laid out and conveniently cross-referenced to one another. Although the size of the book and its lack of island-specific faunal lists will make it somewhat less useful in the field than Riley (1975), it will provide an excellent guide to anyone wishing to curate a collection of butterflies from the West Indies. Although it contains no keys, the clear text descriptions and plates make species identification straightforward. In short, the book is intelligently organized and straightforward to use, in contrast to some other butterfly guides of recent years.

The 24 page introduction begins with an overview of the regional butterfly fauna in context of Nearctic and Neotropical faunas to the north, south and west. Trinidad and Tobago are excluded from coverage in the book, because of their close proximity to Venezuela, and their essentially continental (and much more diverse) assemblage of taxa. Next is a short review of historical biogeography and paleontology of butterflies, and a discussion of the complex and controversial tectonic and biogeographical history of the Caribbean region. An effort is maintained throughout the book to speculate on biogeographic origins of island taxa, some (e.g., *Hypolimnas misippus*) suggested to have dispersed very recently along various corridors, others (e.g., *Calisto* species) thought to have remained sedentary and diverged in situ after isolation by Tertiary vicariant events. A discussion of equilibrium island biogeography and size of island faunas (MacArthur and Wilson, 1967) leads into a section on conservation and extinction. This closes somewhat incongruously with a call to continue building museum collections with specimens of rare and little known taxa. A section on the history of collecting in the various islands in the style of Brown and Heineman (1972) is detailed and carefully researched, with interesting anecdotes about several early natural historians.

Individual species accounts are broken down into five sections. The description gives identifying characters for adult specimens. Range lists the entire distribution of each species (by island or country), and includes type localities. Natural history describes immature characters, food plants and habitat, when known. Most life history information is derived from published sources, and careful citations are provided. Characters and distributions of subspecies are described. Discussion of taxonomic associations, biogeography and intraspecific differentiation is presented at the end of many species descriptions.

I find the absence of any phylogenetic perspective in the book a bit disappointing. The checklist layout could easily have followed a clear hierarchical scheme, but the list of taxa is only explicitly ranked at the family and genus levels. Phylogenetic arrangement of closely-related taxa could provide insight to biogeographical patterns. More importantly, the choice of family-level groups is archaic, although it follows historical precedent (e.g., Riley, 1975; Miller and Brown, 1981). The authors' recognition of families like Riodinidae and Satyridae leaves paraphyletic sister assemblages (Lycaenidae and Nymphalidae, respectively). Harvey's (1991) broadly accepted classification includes such groups as the heliconiines and satyrines within a single large Nymphalidae. The danaines and ithomiines are now considered sister tribes within a single nymphalid subfamily by R. I. Vane-Wright (pers. comm.).

Many of the new species and subspecies added to the region's fauna since Riley (1975) are very similar to previously recognized taxa. Most of them are known from relatively few specimens taken at single localities, often on a single expedition. Life histories of these taxa are rarely described, and diagnoses are often based on wing pattern characters. Intraspecific phenological variation in wing patterns, which may be dramatic in satyrines (e.g., Brakefield and Larsen, 1984; Brunton et al., 1991), could account for the relatively minor differences among some of the *Calisto* species described by Schwartz and Gali (1984) and Gonzalez (1987). Even if these taxa are distinct, the casual butterfly collector is unlikely to encounter them, given their apparently local endemism and rarity.

A final question to consider is, do we really need another book on Antillean butterflies? The authors state that their intention at the beginning of the project was simply to revise and expand Riley's book, following the example of Eliot's (1992) revision of Corbet and Pendlebury's "Butterflies of the Malay Peninsula," but I am unconvinced that our knowledge of the Caribbean fauna has changed so significantly that a big, expensive treatment was necessary. Other regions of the neotropics are sorely lacking guides that provide more than photographs of specimens in the Natural History Museum (London). It would be a greater service to science and butterfly appreciation to produce a book of similar scope on the butterflies of Ecuador or Peru. Nevertheless, taken on its own terms, The Butterflies of the West Indies and South Florida is a successful and comprehensive treatment that demonstrates the maturity of our understanding of the region's fauna, at least at the level of museum collections.—*Andrew V. Z. Brower, Dept. of Entomology, American Museum of Natural History, Central Park West at 79th St., NY, NY 10024.*

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AGELAIA VICINA, A SWARM-FOUNDING POLISTINE WITH THE LARGEST COLONY SIZE AMONG WASPS AND BEES (HYMENOPTERA: VESPIDAE)

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Abstract.—Since von Ihering (1903, 1904), *Agelaia vicina* is famous for its huge nests, but no detailed account has been published. Several nests examined by us were mainly built in shelters but some were half to completely exposed. Main nest characteristics: envelope absent; combs large and horizontal with cells directed downwards; new combs mainly started synchronously and concentrically around several discoidal primordia (Fig. 2A, B, C, D, G); mature nests huge, eventually with more than 7.5 million cells; correspondingly colonies very populous, in Nest 3 described below 482,668 adults actually collected and the whole population estimated at over a million. The nest size (in cell number) and colony size (in adult number) of *A. vicina* is evidently unrivalled among all wasps and bees.

Key words: Agelaia vicina, Social wasps, Largest nest and colony sizes.

The genus *Agelaia* Lepeletier (= *Stelopolybia* Ducke, 1910 auct.; cf. Carpenter and Day, 1988) is the second largest genus (Richards, 1978) among Epiponini, neotropical wasps which found their nests by swarming. Its bionomics have been markedly clarified by Richards and Richards (1951), Richards (1971), Evans and West-Eberhard (1970), Jeanne (1970, 1973, 1975) and Jeanne and Fagen (1974) (reviewed by Jeanne, 1991). Concerning *A. vicina,* since a nest with 108,000 wasps studied by von Ihering (1903), virtually no information has appeared (see also Wenzel, 1992), doubtless because of its colossal size, reputed fierce disposition and dangerous massive attacks. Since 1972, we have examined some nests of *A. vicina.* Most were, when studied, already partly destroyed by local people. Nevertheless, as described below, some interesting data were obtained which may enrich our knowledge on the bionomics of this singular taxon.

RESULTS

A. Characteristics common to the nests

Most items below confirm the description by von Ihering (1903, 1904). 1—Nests generally built within shelters (Fig. 2A, F), but some in partly (Fig. 2D, E, G) or completely exposed (Fig. 1A, B, C) sites. 2—Envelope absent (but, see below). 3—

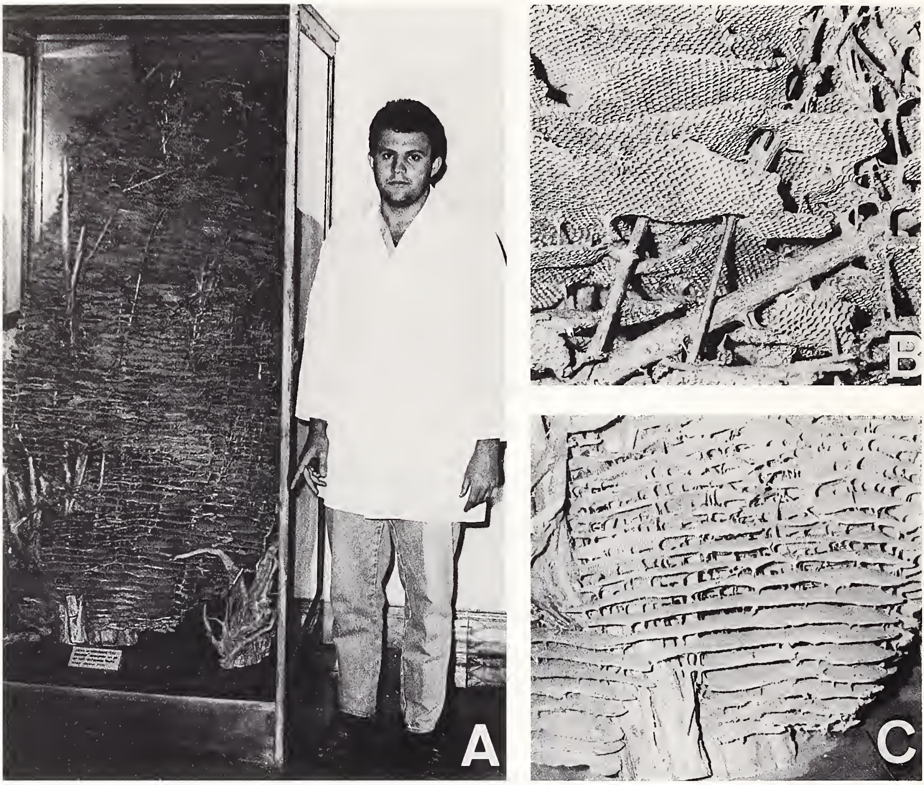

Fig. 1. *Agelaia vicina,* details of Nest 1: A, completely exposed nest involving a dead coffee tree; B, comb architecture around branches and twigs and C, nest's basal part showing horizontal combs, pillars, etc.

Although irregularly undulated and partly distorted, combs predominantly horizontal and fairly even (Figs. 1A, B, 2A–H) never convex and/or concave as in some congeners (Evans and West-Eberhard, 1970; Jeanne, 1973; reviewed by Wenzel, 1991). 4—Each comb predominantly started by synchronously building discoidal primordia, each hanging from the upper comb by a petiole (Fig. 2B, C, H). In lower combs such a state still partly retained, but in upper combs primordia expanding concentrically and fusing with each other to form a single large comb (Fig. 2C, D, F) although inter-comb boundaries often traceable as slits or empty spaces. 5—Connections between upper and lower combs reinforced by additional petioles (Fig. 2C, H). 6—In spite of such concentric expansion, the final comb shape rather ellipsoid, or irregular (Figs. 1A, 2B, D, G), when influenced by spatial limitation. 7—In mature nests, outer contours of combs often beautifully sinuous (Fig. 2D, F) probably by adjoining development between adjacent primordia and suggesting a mean of expanding support for the wasps involved in nest's defense. 8—Well developed combs very large, 1 m or more in longer axis (Fig. 2C, D). 9—Interspace between combs

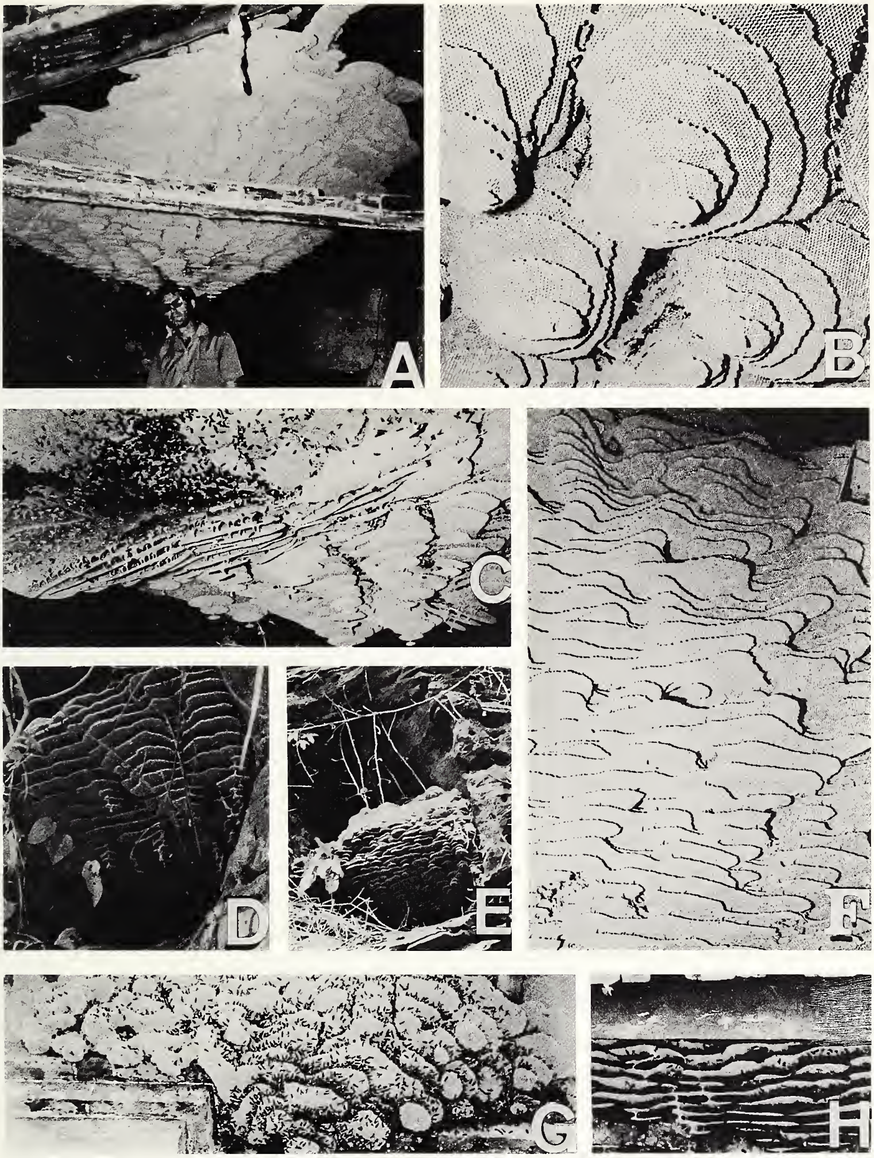

Fig. 2. *Agelaia vicina,* details of nests and nest structure: Nest 3 (A—gross nest shape and size, B—discoidal primordia, C—horizontal combs partially removed to show the brood area inside); Nest 7 (D) and Nest 8 (E) half-exposed in cliff walls; Nest 4 (F—sinuous external limits of combs) and Nest 10 half-exposed at the eaves of a power plant. (G—seen from below, H—seen laterally to show the horizontal combs, pillars and discoidal primordia.)

1.4–2.5 cm. 10—Petioles expanding conically at both ends attached to combs, but cylindrical medially, mostly 2 mm diameter but sometimes 5 mm. 11—Completed cells 6 mm with longer and shorter diameters 2.68 and 2.75 mm, respectively (N = 10 for each measurement). 12—Mean cell number per sq dm 1,127. 13—Meconia and other waste materials sometimes absent in reused young cells suggesting removal through the cell mouth by the adults, but clearly present in reused older cells. 14—Brood concentrated at the nest's core only. 15—Peripheral cells always empty and incomplete probably playing the role of a modified envelope structure, and similar to the envelope-like structure composed of rapidly growing sterile combs found in *A. areata* (Wenzel, 1991).

B. Nests examined

All observed in southern Brazil: Nest 5, in the State of Minas Gerais, the others in the São Paulo State.

Nest 1 (Fig. 1A, B, C) in the collection of Museu do Café, Ribeirão Preto. Illustrated by Costa-Lima (1960:238). Provenance and collection data, unknown. Nesting site unusual, completely unsheltered, built around a coffee tree possibly covered with foliage in the active state 1.65 m high, the largest of 84 combs elliptical, 0.96 × 0.80 m. The whole nest spindle-form, caused by the peculiar nesting site without outward limitation, with middle combs larger than upper and lower ones. Central parts of the combs very irregular with many empty spaces mainly around the trunk and branches (Fig. 1B, C). Assuming each comb to be an ellipse, total comb area 33.58 sq m. Multiplying this with the number of cells per sq dm, total cells estimated at 3,784,466. Regarding parsimoniously each comb as presenting 25% empty spaces (actually certainly less), estimated cell number 2,838,350.

Nest 2. The best studied among the larger nests (Fig. 2A, B, C). Hanging from the ceiling of an abandoned rural house in Fazenda São Gregório, Nuporanga. Examined on Feb. 3, 1976, the surface below was covered with dead wasps from insecticide sprayed three days before. Seen vertically, the whole mass formed an inverted pyramid. From the lowermost incipient cell groups consisting of 31 discoidal areas (Fig. 2A, B, C), 42 comb layers were counted. The gross measures were 2.2 × 2.4 m and 1.1 m (h). Each comb was separated one by one and lain sted side by side. The total comb area was 53.31 sq m and the total number of cells was estimated at 6,008,037, of which 1,983,520 (17.60 sq m) contained the brood (excluding eggs and tiny larvae). Collected dead wasps were sorted to workers (482,668), queens (770) and males (716) by comparing the total weight of adult wasps collected to the weight of a numerically known sample. (For caste differences, von Ihering, 1903; and Sakagami et al., in prep.) However, these values represent only a fraction of adult wasps, all collected in the kitchen, where the nest had been built. Many more remained in the other three rooms, of which the abundant crevices in the damaged wooden floor were full of dead wasps difficult to extract. A search outside revealed many corpses within a radius of 12 m. Moreover, we were told that the fear of the wasps resulted in spraying very inefficiently done. Spray was applied quickly before the dawn through an half-opened window and so the poison reached only one side of the nest. Actually thousands of live callows were present in the core part of the nest (Fig. 2C). The next day a cloud of flying wasps was seen around

Table 1. *Agelaia vicina*: composition of two small but closely analyzed nests.

	Nest 6		Nest 10	
	Frequency	%	Frequency	%
Unused often incomplete fresh cells	470,181	36.44	557,769	74.15
Empty previously used fresh cells	449,379	34.99		
Eggs in fresh cells	2,822	0.21	47,203	6,27
Eggs in reused cells	94,198	7.29		
Small larvae	24,608	1.90	57,783	7.68
Medium larvae	22,050	1.70		
Large larvae	63,328	4.90	89,387	11.88
Cocoons with immatures	164,394	12.77		
Total	1,386,210	99.96	752,139	99.98
Nest's total area (sq m)	12.30	—	6.67	—
Adult wasp:				
workers	157,205	97.05	208,748	97.98
queens	4,717	2.91	672	0.31
males	58	0.03	3610	1.69
total	161,980	99.99	213,030	99.98

the house, evidencing the survival of many adults and suggesting an absconding event. The accurate estimation of the colony population was impossible because of the inevitable partial sampling and plausible migration, but it is sure enough that the number of actually collected wasps represents, even conservatively, about a half of the total adult population, which thus attained over one million wasps. The low queen number found (cf. Nest 10 and Table 1) favors the absconding hypothesis. The queens of the congeneric *A. pallipes* normally gather side by side mainly in the brood area (D. Simões, pers. comm.) which, as in the present case, involves the core of the nest. So, it is likely that many queens protected by combs and worker masses could survive and participate in the subsequent absconding.

Nest 3. Although half-broken when examined, the largest among all closely studied nests (cf. Nest 8, also). Hanging from the ceiling of a brick rural cottage in Santa Rita do Passa Quatro. Abandoned due to poisoning about three months before examination on April 2, 1975. Central part largely damaged but, judging from contour of the remaining parts, about 25% larger than Nest 2, hence approximately with 7,510,046 cells.

Nest 4 (Fig. 2F). An abandoned nest found in a hut about 2 km away from Nest 2 and examined on the same day. The hut, made of bundled grass stems, was a temporary shelter of the kind used by local people, 2.5 m × 2.0 m × 1.8 m (h). Smaller than Nests 2 and 3, 2.23 m × 1.33 m × 0.97 m (h), with the basal surface consisting of 28 discoidal primordia and 48 horizontal comb layers. Its size was estimated at 5,500,000 cells.

Nest 5. Built in a recreation house of sporadic use, in Sacramento. Examined in late March, 1976, after insecticide treatment. Clearly smaller than the previous nests, 1.05 m × 0.67 m × 0.60 m (h). Although not closely studied, the nest is interesting for evidencing the end of gyne production. Many adult workers were found dead among combs, but all recognizable pupae in cells were gynes, whose cocoons differ

from those of workers, being about 1.5 mm high, milky and tough. The rather small nest size indicates colony maturity (reproductive phase), reached much earlier than the realization of the maximum colony size. A similar conclusion can be drawn from the similar sized colony examined by von Ihering (1903) as he found among the true queens many uninseminated gynes.

Nest 6. Collected in a farm corn-mill in Rifaina on May 7, 1976, with ether treatment, for the colony was fully active. A small nest, but exact colony and nest sizes could be determined. The nest had occupied a wooden-box (65 cm × 53 cm × 70 cm, h). Wasps entered the combs through several crevices in a lateral part of the box. The box was completely sealed above with the carton-made dorsal part of the top comb which was made thick by the addition of much more wood pulp than usual. On this account the former cells below disappeared almost completely as substituted by many thick pillars which turned this outer envelope spongy-like and about 1 cm thick. Most combs were broken at removal but some ones taken intact exhibited a sharp alternation of different brood stages, suggesting an emergence-oviposition cycle. Total comb area 12.30 sq m, with 1,386,210 cells of the contents given in Table 1. All adults were fixed in Dietrich fluid, then kept in 70% alcohol. Total colony size (157,205 workers, 4,717 queens and 58 males) was estimated using the same method as in nest 2. Nest 6 was also small but probably in a more advanced stage of the reproduction cycle than Nest 5, exhibiting the end of the queen production phase followed by the beginning of the next worker production. The shift was less neat than in Nest 5, but all examined gyne pupae were of more advanced stages than worker ones. The high queen number is surely the outcome of the reproduction phase in which the nest surely was as demonstrated by the presence of very old, callow and young queens living together.

Nests 7 (Pedregulho, Aug, 10, 1976; Fig. 2D), 8 (ditto, Sept. 16, 1976; Fig. 2E), 9 (Rifaina, Oct. 10, 1976). All found in high (more than 30 m) cliff walls being active and impossible to collect. General features as in other nests, but not hanging from a support. Instead, lateral parts of the combs were attached to the lateral wall of the cliff cavity. Combs are larger at the middle, gradually smaller in upper and lower parts, resulting in a rhombic figure seen laterally. Nest 8 is probably the largest we have seen. For the discoidal primordia seen above and below (Fig. 2E) it is clear that a nest can sometimes concomitantly grow upwards and downwards. These peculiar architectural aspects will be discussed elsewhere.

Nest 10 (Fazenda Santa Carlota, Cajuru, May 20, 1993; Fig. 2G, H). Smaller than nest 6 and equally active. Half exposed in the eaves of a power plant about 6m high. Nest composition could be accuratedly determined (Table 1) because it was ether sprayed very early in the morning. Concerning colony cycle it was clearly at an earlier stage than nest 6. Males were abundantly present, but dissected queens (575 out of 672) invariably showed equivalent ovarian conditions, suggesting quite uniform relative age distribution. It seems likely that such queens represent the founder cohort taking part in colony settlement after swarming.

DISCUSSION

Including the three nests examined by von Ihering (1903), one in a hollow trunk and two in man-made constructs, records of 13 *A. vicina* nests are now available.

Nests built in shelters prevail (8 cases) but half-exposed (4 cases) and a completely exposed nest (Nest 1) suggest plastic and synanthropic (8 cases) nest site preference.

The most outstanding trait of *A. vicina* is certainly the production of gigantic colonies. The reliable values are scarce but in Nest 6 and 10, which are rather small, colony size was estimated at 161,908 and 213,030, respectively. In addition, 482,668 wasps were actually collected in Nest 2 as a fraction of certainly over 1 million wasps.

The large colony size of *A. vicina* may be compared with some other social wasps and bees. In bees the colony of the European honey-bee is often cited as populous but rarely attaining 35,000 individuals (Harbo, 1986). In stingless bees, some species of the subgenus *Trigona* construct large colonies and, probably, the largest is *T. amazonensis.* A colony examined in Curicurieri, Alto Rio Negro, AM. was 2.6 m high × 0.6 m wide, with 40 combs and probably 150,000–200,000 bees (Camargo, J.M.F.; pers. comm.).

Some populous colonies in social wasps are: *Brachygastra mellifica* 15,000 (Schwarz, 1929); *Protopolybia acutiscutis* (= *P. pumila* auct.) 21,600 (Richards and Richards, 1951); *Agelaia areata* 21,800 (Jeanne, 1975); *Ropalidia montana* 61,000 (Jeanne and Hunt, 1992). The only case comparable to *A. vicina* is *Vespula germanica,* introduced to New Zealand and Tasmania. In Europe this species is annual, with the maximum colony size (number of adults emerged) not much exceeding 10,000 (Spradbery, 1973). In the introduced areas some colonies overwinter and continue to the next autumn, attaining colossal nest and colony sizes (Thomas, 1960; Spradbery, 1973). The largest aerial nest reached 4.6 m long and 2.4 m wide with about 180 combs, probably containing 3–4 million cells and over 300,000 workers. This example is noteworthy and it demonstrates the potential of the species under artificial induced situations, not the normal development exhibited in the autochthonous condition. A similar situation occurs in Brazil. The hybrids of the introduced African bee *Apis mellifera scutellata* can form huge colonies probably through the joining of several swarms in the course of the migration (Kerr, W.E.; pers. comm.). Unfortunately, such an interesting event remains unexplored.

It must be mentioned that gigantic colonies of wasps and bees are far exceeded by some ants. Only two extreme cases are cited: 1—a migratory colony of the African driver ant *Anomma wilverthi* contained, despite monogyny, 15–22 million workers (Raignier and van Boven, 1955). 2—a polydomous supercolony of *Formica* (*Formica*) *yessensis* which had been extended for 20 km along Ishikari Shore, Japan (now dismembered and nearly exterminated), consisted of 72,000 nests, or 35 million ants (Itô, 1971, 1973).

Besides the colossal colony size, von Ihering (1903) discovered another peculiarity of *A. vicina,* distinct morphological differences between queens and workers. This aspect will be detailed in another paper. Here a few words are given on some bionomic aspects of *A. vicina,* for which answers would be fascinating though very difficult to obtain: 1—Whether mature colonies issue swarming parties larger than in other epiponine species or more numerous but same sized parties as in other species? 2—How long is the foraging distance of each worker? What animals are the principal prey? How is foraging ability balanced with the prey density? 3—What factors mainly regulate the colony density? 4—What animals are principal enemies

and how these are effectively defended? 5—Why and how does this species realize such large colony size?

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REVISION OF THE INTERTIDAL ALEOCHARINE GENUS *AMBLOPUSA* CASEY AND DESCRIPTION OF THE NEW GENUS *PARAMBLOPUSA* (COLEOPTERA: STAPHYLINIDAE)[1]

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Abstract.—A systematic revision of the aleocharine genus *Amblopusa* Casey is presented. *Amblopusa* Casey is redescribed, and three species are recognized, two of which are new (*A. alaskana* Ahn and Ashe and *A. hokkaidona* Ahn and Ashe). Late instar larvae of *A. alaskana* Ahn and Ashe are described. *Boreorhadinus* Sawada is synonymized under *Amblopusa* Casey and *Boreorhadinus pacificus* Sawada is synonymized under *A. brevipes* Casey. Type and paratypes of *A. alaskana* and *A. hokkaidona* are designated. Lectotype is designated for *A. brevipes.* New genus *Paramblopusa* is described to contain *A. borealis.* Lectotype and paralectotypes are designated for *P. borealis.* A key is provided for separation of the genera *Amblopusa* and *Paramblopusa* and the known species of *Amblopusa,* and illustrations of diagnostic features are presented.

Members of the aleocharine genus *Amblopusa* Casey are confined to the seashore of Pacific North America and Japan. The genus was first described and characterized by Casey in 1893 based on the new species *A. brevipes* from the coast of Alaska. Later, Casey (1906) described an additional species, *A. borealis* from the coast of Queen Charlotte Islands (Massett). In 1911, Casey described another species, *A. pallida* from Vancouver Island (Victoria). However, *A. pallida* was synonymized under *A. brevipes* by Fenyes (1918). Therefore, currently two valid species have been proposed in the genus *Amblopusa.*

Cladistic analyses of the tribe Liparocephalini (Ahn and Ashe, in press), and discovery of two undescribed species, one of which was associated with larvae from Alaska (USA) and the other from Hokkaido (Japan), and the syntype series of *A. brevipes* and *A. borealis* Casey in the collections of the NMNH provided us with the opportunity to revise the genus *Amblopusa* Casey and to describe the new genus *Paramblopusa.*

In this paper we redescribe *Amblopusa* Casey and *A. brevipes* Casey, describe two new species (*A. alaskana* and *A. hokkaidona*) and associated late instar larvae of *A. alaskana,* synonymize *Boreorhadinus* Sawada under *Amblopusa* Casey and *Boreorhadinus pacificus* Sawada under *A. brevipes* Casey, and describe the new genus *Paramblopusa* to contain *A. borealis* Casey.

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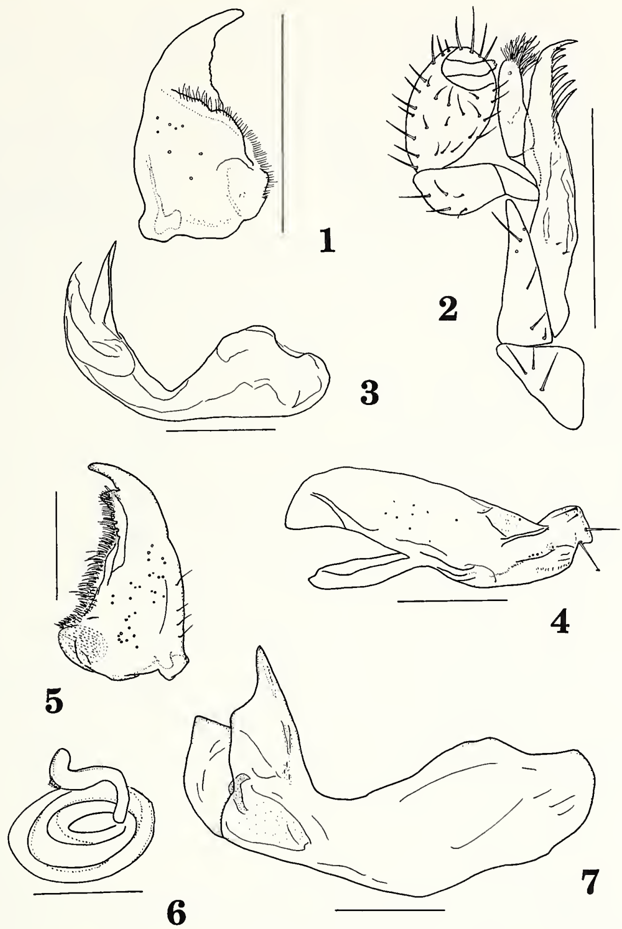
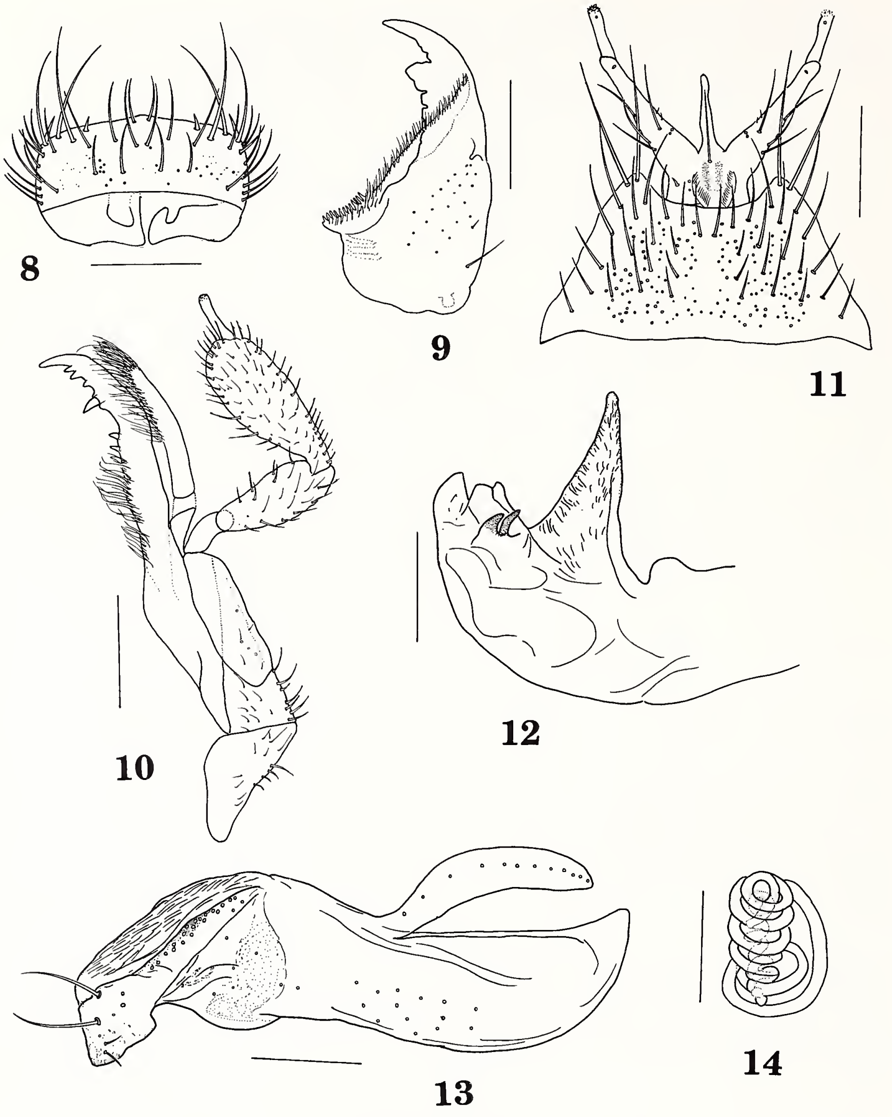


Figs. 1–7. *Amblopusa hokkaidona* Ahn and Ashe, 1–4 and *Amblopusa brevipes* Casey, 5–7. 1, Mandible, ventral aspect; 2, Maxilla, dorsal aspect; 3, Median lobe, lateral aspect; 4, Paramere, lateral aspect; 5, Mandible, dorsal aspect; 6, Spermatheca, dorsal aspect; 7, Median lobe, lateral aspect. Scale, 0.1 mm.

Amblopusa Casey

Amblopusa Casey, 1893: 355, 1906: 354, 1911: 212; Fenyes, 1918: 104; Bernhauer and Scheerpeltz, 1926: 550; Blackwelder, 1952: 48; Moore, 1956: 127; Hatch, 1957: 148; Moore and Legner, 1975: 339, 1976: 532; Seevers, 1978: 172.
Boreorhadinus Sawada, 1991: 147. **New synonym.**

Diagnostic Combination. Among aleocharine genera with 4-4-5 tarsal formula members of *Amblopusa* are easily recognized by the combination of: short body pubescence; very small eyes (ratio of eye length to head length less than 0.1); transverse labrum (Fig. 8); lacinial setae only on mesal surface (Figs. 2 and 10); several



Figs. 8–14. *Amblopusa alaskana* Ahn and Ashe. 8, Labrum, dorsal aspect; 9, Mandible, ventral aspect; 10, Maxilla, dorsal aspect; 11, Labium, dorsal aspect; 12, Median lobe, lateral aspect; 13, Paramere, lateral aspect; 14, Spermatheca, dorsal aspect. Scale, 0.1 mm.

galeal setae only on mesal surface (Figs. 2 and 10); one medial seta on labium or none (Fig. 11); mentum more or less trapezoidal and v setae absent; ratio of pronotal length to elytral length ratio 1.0–1.3; mesocoxal cavities contiguous; metasternum longer than half length of mesocoxal cavity; anterior margin of abdominal tergites III–VI deeply and broadly V-shaped; abdominal tergites III–VII strongly impressed

at base; distal part of abdominal tergite X not sclerotized; hind wings absent; distinctive secondary sexual characteristics; and occurrence in the intertidal zone of seashores.

Description. Small; body length 1.4–3.0 mm. Body shape narrow, flattened and parallel-sided. Body color variable: dark brown, reddish brown, brown, or light brown. Body pubescence with short microsetae more or less uniformly distributed and macrosetae scattered.

HEAD. Slightly deflexed, ≈1.0–1.1 times as long as wide. Eyes very small; ratio of eye length to head length less than 0.1. Neck absent. Microsetae dense, macrosetae absent. Antenna with 11 antennomeres; antennomeres 2–3 each shorter than preceding; each antennomere with several microsetae.

MOUTHPARTS. Labrum (Fig. 8) transverse; major setae distinct, additional setae present, sensilla on anterior margin; epipharynx with many pores medially. Mandibles (Figs. 1, 5, 9) with apices more or less acute and slightly curved downward; prostheca well-developed, membranous with fibrils. Maxilla (Figs. 2 and 10) with galea and lacinia elongate; galea shorter and narrower than lacinia or same size, corneous, its apex densely pubescent with long filiform setae, and a row of setae only on mesal surface; lacinia more or less acutely pointed, internal surface with comb of single row of 8–10 well separated spines followed by several setae, or internal surface with large, strongly curved apical tooth and 4 short spines more apically and 1 larger spine behind these 4, and a distinctive row of several setae only on mesal surface; maxillary palpus with 4 articles, robust, article 3 ovoid or incrassate and longer than 2, 4 narrow distally with indistinct sensilla. Labial palpi (Fig. 11) with 2 articles, substyliform and elongate; twin pores and median pore present or absent; ligula elongate, entire at apex; prementum with or without 1 medial seta, real pores always present, pseudopores present or absent, basal pores always absent, setal pores present or absent; a pair of indistinct comb-like hypoglossae present adorally. Mentum (Fig. 11) more or less trapezoidal; v setae absent, several long setae present.

THORAX. Pronotum subquadrate, about as long as wide, narrowest at base, widest near apex, basal lines almost straight, apical lines very slightly projected anteriorly; pattern of pubescence with setae subparallel and directed anteriorly in a narrow median strip, others directed antero-laterally; microsetae densely and uniformly distributed, macrosetae sparse, indistinct, mostly at sides. Hypomera large, entirely visible in lateral aspect. Mesocoxal cavities contiguous; mesosternal process acute. Metasternum medium-sized. Tibiae without spinules; tarsal formula 4-4-5; claws more or less elongate and curved.

ELYTRA. Elytra 0.8–0.9 times as long as pronotum; lateral length greater than medial length, microsetae numerous, directed more or less posteriorly, uniformly distributed, macrosetae sparse, mostly at sides. Hind wings absent.

ABDOMEN. General shape broad at base and sides uniformly converging to rounded apex; microsetae numerous, directed posteriorly, uniformly distributed; macrosetae inconspicuous, sparse. Anterior margin of abdominal tergites III–VI deeply and broadly V-shaped. Tergites III–VII strongly impressed at base. Sternites III–VII constricted or not constricted at base. Tergite X with 4 pairs of distinct major setae, numerous unsclerotized additional setae present.

SECONDARY SEXUAL CHARACTERISTICS. Sternite VIII of male prolonged posteriorly as broad triangular projection. Female unmodified.

AEDEAGUS. Median lobe (Figs. 3, 7, 13). Paramere (Figs. 4, 14).

SPERMATHECA. (Figs. 6, 12) Long, slender, coiled.

Type Species. *A. brevipes* Casey, designated by Fenyes (1918).

Distribution. From Alaska to California in North America, and Hokkaido (Japan).

Biology and Ecology. Members of the genus *Amblopusa* inhabit the mid-littoral zone of rocky shores, which contains *Fucus* and barnacles (Moore and Legner 1976). They are often found associated with *Diaulota* and *Liparocephalus.* Tens of individuals of *A. alaskana* have been observed under one boulder at the low-littoral zone of the seashore covered with thousands of pebbles (pers. obs.)

KEY TO THE SPECIES OF THE GENUS *AMBLOPUSA*

1. Mandible with indistinct serration on internal surface (Fig. 1); lacinia with ≈10 spines of subequal size in a row near apex (Fig. 2); galea not distinctly shorter and narrower than lacinia; lengths of anterior and middle tarsomere 4 subequal to each of 1, 2, and 3; apical process of median lobe not projected upward (Fig. 3) . . . . *A. hokkaidona*
   Mandible with small and irregular serration on internal part (Figs. 5 and 9); lacinia distinctive, with large, strongly curved apical spine; 4 short spines more medially and 1 large spine behind these (Fig. 10); galea shorter and narrower than lacinia; length of anterior and middle tarsomeres 4 subequal to 1 + 2 + 3 together; apical process of median lobe projected upward 2
2. Body length 1.9–2.2 mm; ligula of labium short, ≈0.3 times length of apparent article 1 of labial palpus; pronotum not longitudinally impressed; abdominal sternites IV–VI constricted at base; aedeagus as in Figure 7 . . . . *A. brevipes*
   Body length 2.4–3.0 mm; ligula (Fig. 11) relatively long, almost half length of labial palpus; pronotum slightly impressed longitudinally; abdominal sternites not constricted at base; aedeagus as in Figures 13 and 14 . . . . *A. alaskana*

Amblopusa hokkaidona, new species

Description. Body length 1.4 mm. Body color dark brown or brown.

Head ≈1.1 times as long as wide. Antennomeres 4–10 transverse. Labrum very slightly projected anteriorly, sensilla on anterior margin. Mandibles (Fig. 1) with indistinct internal serration, without median tooth. Labial palpi with 2 articles, article 1 ≈2 times length of article 2, twin pores and median pore absent. Submentum with widely scattered punctures and setae, with distinct microsculpture. Article 3 of maxillary palpus ovoid. Lengths of anterior and middle tarsomere 4 subequal to each of 1, 2, and 3. Pronotum subquadrate. Elytra ≈1.9 times as long as wide; ≈0.9 times as long as pronotum.

AEDEAGUS. Median lobe (Fig. 3). Paramere (Fig. 4).

Type Series. Holotype, male, and allotype, female, each labeled as follows: 'JAPAN, Hokkaido, Akkeshi, Tokotan, 15 June 1994, K. J. Ahn: Holotype (or Allotype), *Amblopusa hokkaidona* Ahn and Ashe, Desig. K. J. Ahn and J. S. Ashe, 1994.' Both holotype and allotype are deposited in the Snow Entomological Museum, University of Kansas, Lawrence, Kansas. Paratypes, 2 (1 on slide), same data as type.

Distribution. Hokkaido, Japan.

Amblopusa brevipes Casey

Amblopusa brevipes Casey, 1893: 356; Bernhauer and Scheerpeltz, 1926: 550; Moore, 1956: 128; Hatch, 1957: 149; Moore and Legner, 1975: 339.
Amblopusa pallida Casey, 1911: 212.
Boreorhadinus pacificus Sawada, 1991: 147. **New synonym.**

Description. Body length 1.9–2.2 mm. Body color reddish brown or brown.

Head about as long as wide. Antennomeres 4–10 transverse, 3–11 increasing in width toward apex. Labrum slightly projecting anteriorly, sensilla of anterior margin present. Mandible (Fig. 5) with irregular serration. Labial palpi with 2 articles, substyliform, article 2 ≈0.3 times length of 1; ligula ≈0.3 times length of article 1; twin pores and median pores present, prementum without pseudopores medially and laterally, without basal pores; setal pores present. Maxilla with galea shorter and narrower than lacinia; article 3 palpus ovoid; internal surface of lacinia with large spine apically, 4 short spines more medially and 1 large spine behind these. Submentum with numerous punctures and setae; ratio of size of punctures to average distance between punctures ≈0.3. Pronotum subquadrate. Lengths of anterior and middle tarsomere 4 subequal to tarsomeres 1 + 2 + 3 together. Elytra ≈1.7 times as long as wide, ≈0.8 times as long as pronotum.

AEDEAGUS. Median lobe (Fig. 7).

SPERMATHECA. (Fig. 6).

Type series. Lectotype, male, here designated, in the National Museum of Natural History, Washington, D.C., with labels as follows: 'Ft. Wrangell, Alaska, Wickham, Casey bequest 1925; Lectotype, *Amblopusa brevipes* Casey, Desig. K. J. Ahn and J. S. Ashe, 1994'.

Material Examined. CANADA: British Columbia, Massett (CAS, 3). UNITED STATES: Alaska: Ft. Wrangell, Wickham, 1891, T. L. Casey (CAS, 1; KSEM, 1); California: Marin Co.: Bolinas Beach, 30 March 1971, D. Giuliani (UCR, 1).

Distribution. From California to Alaska.

Comments. Unfortunately, repeated attempts to obtain a loan of the type series of *Boreorhadinus pacificus* Sawada from Japan were not successful. Nevertheless, We are confident that *B. pacificus* is synonym of *A. brevipes* because detailed descriptions and extensive figures by Sawada (1991) agree with *A. brevipes* very well.

Amblopusa alaskana, new species

Description. Body length 2.4–3.0 mm. Body color dark brown.

Head about as long as wide. Antennomeres 7–10 transverse, 3–11 increasing in width toward apex. Labrum (Fig. 8) slightly projecting anteriorly, sensilla present. Mandible (Fig. 9) with irregular serration. Labial palpi (Fig. 11) with 2 articles, substyliform, article 2 ≈0.3 times length of article 1; ligula long, more than half length of article 1 of palpus; medial seta present or absent; twin pores and median pores present; prementum without pseudopores medially and laterally, without basal pores, setal pores present. Maxilla (Fig. 10) with galea much shorter and narrower than lacinia; article 3 of palpus dilated; internal surface of lacinia with large spine apically, 4 short spines more medially and 1 large spine behind these. Submentum with numerous densely arranged punctures and setae; ratio of setal width to average

distance between punctures ≈0.3–0.4. Pronotum subquadrate, with slight medial longitudinal impression. Lengths of anterior and middle tarsomeres 4 subequal to tarsomeres 1 + 2 + 3 together. Elytra ≈0.9 times as long as pronotum.

AEDEAGUS. Median lobe (Fig. 13). Paramere (Fig. 14).

SPERMATHECA. (Fig. 12).

Type Series. Holotype, male, and allotype, female, each labeled as follows: 'USA, Alaska, Seward, 24 May 1994, K. J. Ahn; Holotype (or Allotype), *Amblopusa alaskana* Ahn and Ashe, Desig. K. J. Ahn and J. S. Ashe, 1994.' Both holotype and allotype are deposited in the Snow Entomological Museum, University of Kansas, Lawrence, Kansas. Paratypes, 64 (4 on slides), same data as type; 2, USA, Alaska, Seward, 25 May 1994, K. J. Ahn (KSEM); 3, Alaska, Valdez, 1 Aug. 1978, P., P.-H. Madaline and S. Arnaud (CAS); 1, Alaska, Unalaska, Dutch Harbor, 14 Aug. 1907, Van Dyke (CAS); 2, Alaska, Unalaska, Dutch Harbor, 9 July 1907, Van Dyke (CAS).

Distribution. Alaska: Dutch Harbor, Valdez, Seward.

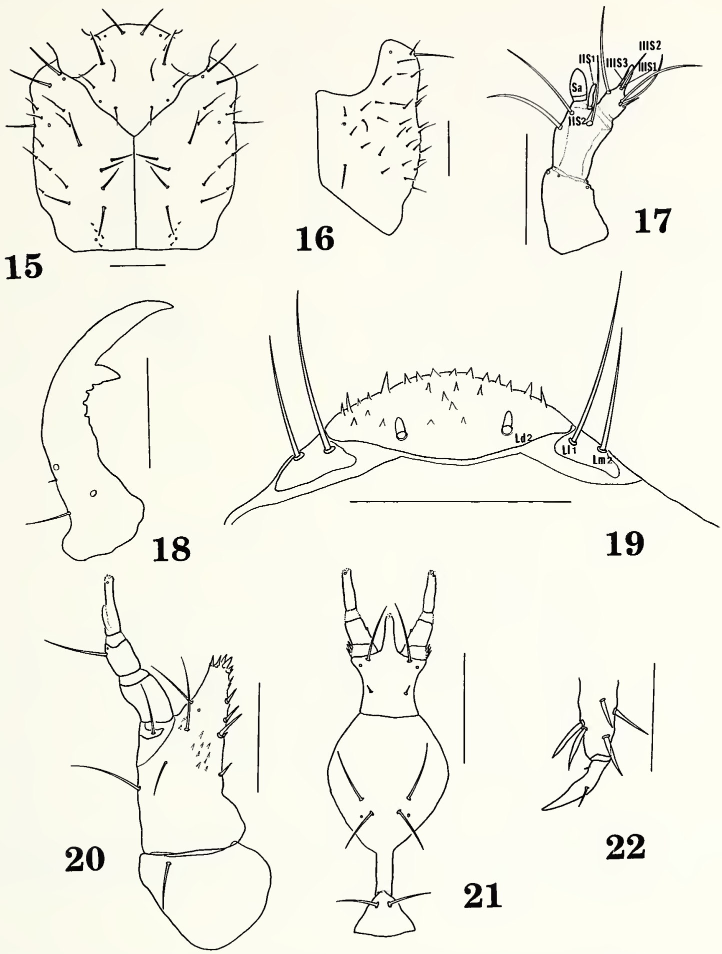
Description of late instar larvae of *Amblopusa alaskana*
(Chaetotaxic system according to Ashe and Watrous 1984)

Diagnostic Combination. Larvae of *Amblopusa alaskana* can be distinguished from all other described aleocharine larvae by the combination of: elongate antenna (Fig. 17) with IIS3, IIIS4 absent; distinctive pattern of spines and setae on labrum (Fig. 19); mandible (Fig. 18) pointed and hooked apically; large median tooth on each mandible and distinct serration between median tooth and molar region; labium (Fig. 21) with 3–5 short spines on lateral margin; maxilla (Fig. 20) with broad stipes; very narrow and unsclerotized submentum; tarsus (Fig. 22) with 1 robust dorsal spine; urogomphus (Fig. 26) fused to main body; presence of 4 large, sclerotized hooks on pygopodium (Fig. 26); and, many additional setae (in comparison with standard patterns described by Ashe and Watrous) on head, pronotum, mesonotum and abdominal tergites.

Description. Length of 2.5 mm. General body shape elongate, flattened, parallel-sided. Color light brown.

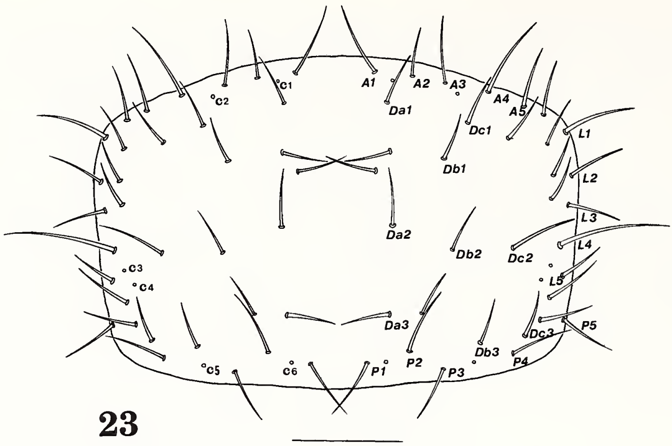
HEAD. About 0.9 times as wide as long. Stemma indistinct on each side, very small. Ecdysial sutures distinct and complete from antennal fossae anteriorly to base of head posteriorly. Setation as in Figures 15 and 16. Antenna (Fig. 17) with 3 articles; article 1 elongate, ≈1.4 times as long as wide, with 5 campaniform sensilla around apical margin; article 2 ≈0.9 times length of article 1; article 3 ≈0.5 times length of article 2; article 2 with 2 solenidia in addition to sensory appendage; sensory appendage robust, inflated, acorn-shaped and faintly fenestrate, its length almost equal to length of article 3; IIS1 spiniform, very short, ≈0.2 times as long as IIS2; IIS2 elongate, digitiform, about as long as sensory appendage, IIS3 absent; article 3 with 3 solenidia in addition to sensory appendage; IIIS3 digitiform, faintly fenestrate, IIIS4 absent.

MOUTHPARTS. Labrum (Fig. 19) with 3 distinct setae on each side and several short and robust spines, Ll1 and Lm2 on small lateral sclerite distinctly separated from main body of labrum by suture; seta Ld1 absent, seta Ld2 very short, robust and inflated. Mandibles (Fig. 18) with symmetrical, pronounced preapical tooth and



Figs. 15–22. *Amblopusa alaskana* Ahn and Ashe, late instar larva. 15, Head, dorsal aspect; 16, Head, ventral aspect; 17, Antenna, ventral aspect; 18, Mandible, dorsal aspect; 19, Labrum, dorsal aspect; 20, Maxilla, ventral aspect; 21, Labium, dorsal aspect; 22, Tarsus, dorsal aspect (symbols according to Ashe and Watrous 1984). Scale, 0.1 mm.

large median tooth, distinct serration between median tooth and molar region; 2 setae in basi-lateral half, distal seta very small and basal seta large. Maxilla (Fig. 20) with cardo broadly oval, with one seta on ventro-lateral surface; stipes broad at base, not distinctly separated from mala, surface with 2 large setae, 1 on disk and 1 near lateral margin; mala with apex acute, 5 spiniform setae on mesal region with large seta most basal; scale at base of most basal seta spinose, very short, less than 0.1 times length of seta, several short spinules scattered on dorsal surface; maxillary palpus with 3 articles and basal crescentic palpifer; article 1 elongate, ≈0.8 times as wide as long; article 2 ≈0.8 times as long as article 1; article 3 ≈0.7 times as long



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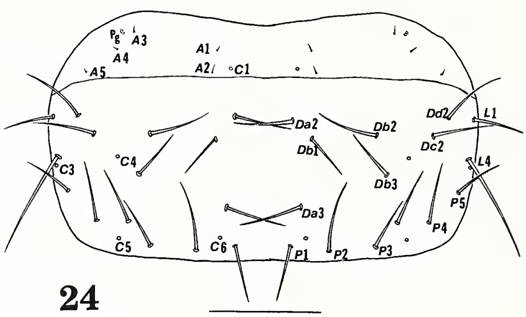

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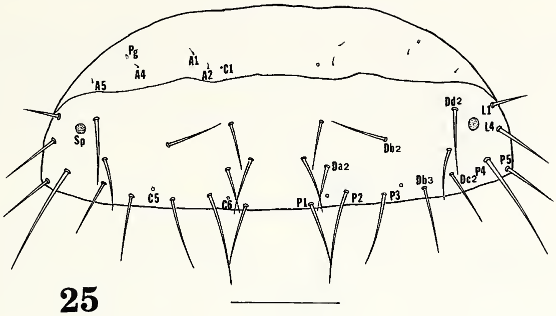
Figs. 23–24. *Amblopusa alaskana* Ahn and Ashe, late instar larva. 23, Pronotum, dorsal aspect; 24, Mesonotum, dorsal aspect (symbols according to Ashe and Watrous 1984). Scale, 0.1 mm.

as article 1 and 2 together; article 3 with basal digitiform sensory appendage on external surface. Labium (Fig. 21) consisting of indistinctly separated prementum, mentum, and very narrow, unsclerotized submentum; ligula elongate; labial palpus with 2 articles, article 2 $\approx$1.4 times as long as article 1; submentum with 1 pair of setae; mentum with 2 pairs of setae and 1 pair of campaniform sensilla; prementum with 2 pairs of setae and 1 pair of campaniform sensilla; 3–5 short spines present on antero-lateral margin of labium.

THORAX. Pronotum (Fig. 23) transverse; chaetotaxy with anterior, lateral, and posterior rows complete and discal rows complete (A1–A5, L1–L5 and P1–P5 present, Da1–Da3, Db1–Db3, Dc1–Dc3, and Dd1–Dd2 present; 8 additional setae present, 2 between Da1 and Da2, 1 between Da3 and Db3, 1 between Dc3 and P4, 1 between L5 and P5, 2 between Dc1 and L3, 1 between A5 and L1), campaniform sensilla C1–6 present. Mesonotum (Fig. 24) transverse; chaetotaxy with anterior, lateral, and posterior rows complete and discal rows complete (A1–A5, L1 and L4,



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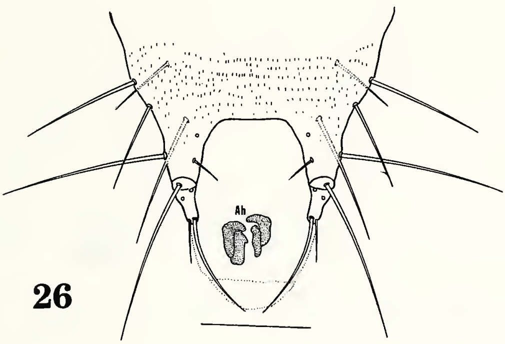

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Figs. 25–26. *Amblopusa alaskana* Ahn and Ashe, late instar larva. 25, Abdominal tergite I, dorsal aspect; 26, Abdominal tergite IX, dorsal aspect (symbols according to Ashe and Watrous 1984). Scale, 0.1 mm.

P1–P5, Da2 and Da3, Db1–Db3, Dc2, and Dd2 present; 1 additional seta present between Db3, P3, and P4), campaniform sensilla C1, C3, C4, C5, and C6 present. Metanotum similar to mesonotum.

LEGS. Tarsus (Fig. 22) with 1 robust dorsal spine.

ABDOMEN. Abdominal tergites I–VII transverse; abdominal tergite I (Fig. 25) chaetotaxy with anterior, lateral, and posterior rows complete and discal rows complete (A2, A4, A5, L1, L4, P1–P5, Da2, Db2, Dc2, and Dd2 present); 4 additional setae present; 1 more anterior seta (A3), 2 more above Da2, 1 more between Db2, Dc2, and P4. Tergal gland reservoir slightly sclerotized, with distinctive pattern of internal hoop-like sclerotizations; 4 gland ducts, in form of coiled tubules. Abdominal tergites IX–X as in Fig. 26; urogomphi fused to main body, short, ≈0.2 times length of tergite IX, apex not pointed beyond subapical seta, each urogomphus displaced from main body of tergum IX on short posterior elongation of postero-lateral margin of tergum. Pygopodial hooks (2 pairs) large, sclerotized, and well-developed.

Material Examined. UNITED STATES: Alaska: Seward, 24 May 1994, K. J. Ahn (KSEM, 5).

Remarks. The larvae were described here collected in association with adults of *A. alaskana* in Alaska; there were no other larvae or adults of any other aleocharine species present; and, larvae of other possible species of intertidal Aleocharinae are known to us and are distinctly different from these larvae. Therefore, we have described them as probable larvae of *A. alaskana.*

Paramblopusa, new genus

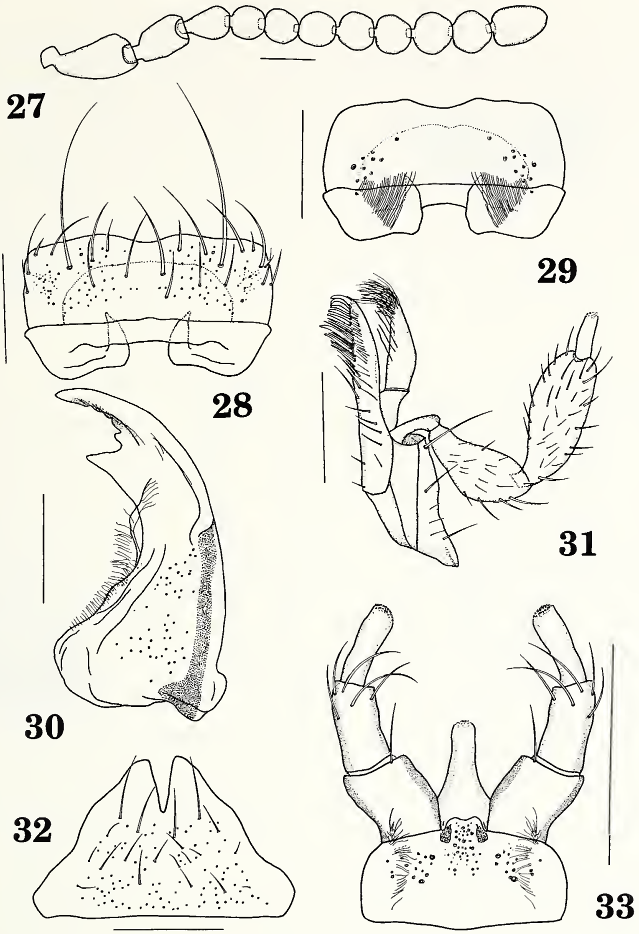
Diagnostic Combination. Among aleocharine genera with 4-4-5 tarsal formula members of *Paramblopusa* are recognized by the combination of: short body pubescence; small eyes (ratio of eye length to head length less than 0.2); labrum (Fig. 28) transverse; mandibles (Fig. 30) with small teeth between apex and median tooth; lacinial setae only on mesal surface (Fig. 31); several galeal setae only on mesal surface (Fig. 31); one medial seta on labium or none (Fig. 32); mentum (Fig. 33) triangular, deeply incised with V-shaped emargination at apex and v setae absent; mesocoxal cavities contiguous (Fig. 34); metasternum longer than half length of mesocoxal cavity; abdominal tergites III–VII strongly impressed at base; distal part of abdominal tergite X not sclerotized (Fig. 36); hind wings absent; distinctive secondary sexual characteristics (Fig. 35); and occurrence in the intertidal zone of seashores.

Description. Small; body length 2.5–3.4 mm. Body shape narrow, flattened and parallel-sided. Body color variable: dark brown, reddish brown, brown, or light brown. Body with short microsetae more or less uniformly distributed and macrosetae scattered.

HEAD. Slightly deflexed, ≈0.9 times as long as wide. Eyes very small; ratio of eye length to head length less than 0.2. Neck absent. Microsetae dense, more or less uniformly distributed, macrosetae absent. Antenna (Fig. 27) with 11 antennomeres; antennomeres 2–3 each shorter than preceding; each antennomere with several microsetae.

MOUTHPARTS. Labrum (Fig. 28) transverse; major setae distinct, additional setae present; epipharynx (Fig. 29) with many pores scattered in medial row. Mandibles (Fig. 30) with apices more or less acute, slightly curved downward at tip; prostheca well-developed, membranous, with fibrils. Maxilla (Fig. 31) with galea and lacinia elongate; galea corneous, apex densely pubescent with long filiform setae, and row of setae only on mesal surface; lacinia more or less acutely pointed, internal surface with comb of single row of 8–10 well separated spines followed by several setae, and a distinctive row of several setae only on mesal surface; maxillary palpus with 4 articles, robust, article 3 ovoid and longer than 2, 4 narrow distally with indistinct sensilla. Labial palpi (Fig. 32) with 3 articles, substyliform; twin pores and median pore absent; ligula elongate, entire at apex; prementum with 1 medial seta or none, real pores always present; a pair of indistinct comb-like hypoglossae present adorally. Mentum (Fig. 33) more or less triangular, deeply incised with V-shaped emargination at apex; v setae absent, several long setae present.

THORAX. Pronotum subquadrate, about as long as wide, narrowest at base and widest near apex, basal lines almost straight, apical lines slightly projected anteriorly; pattern of pubescence with setae subparallel and directed anteriorly in narrow median strip, others directed antero-laterally; microsetae densely and uniformly distributed,

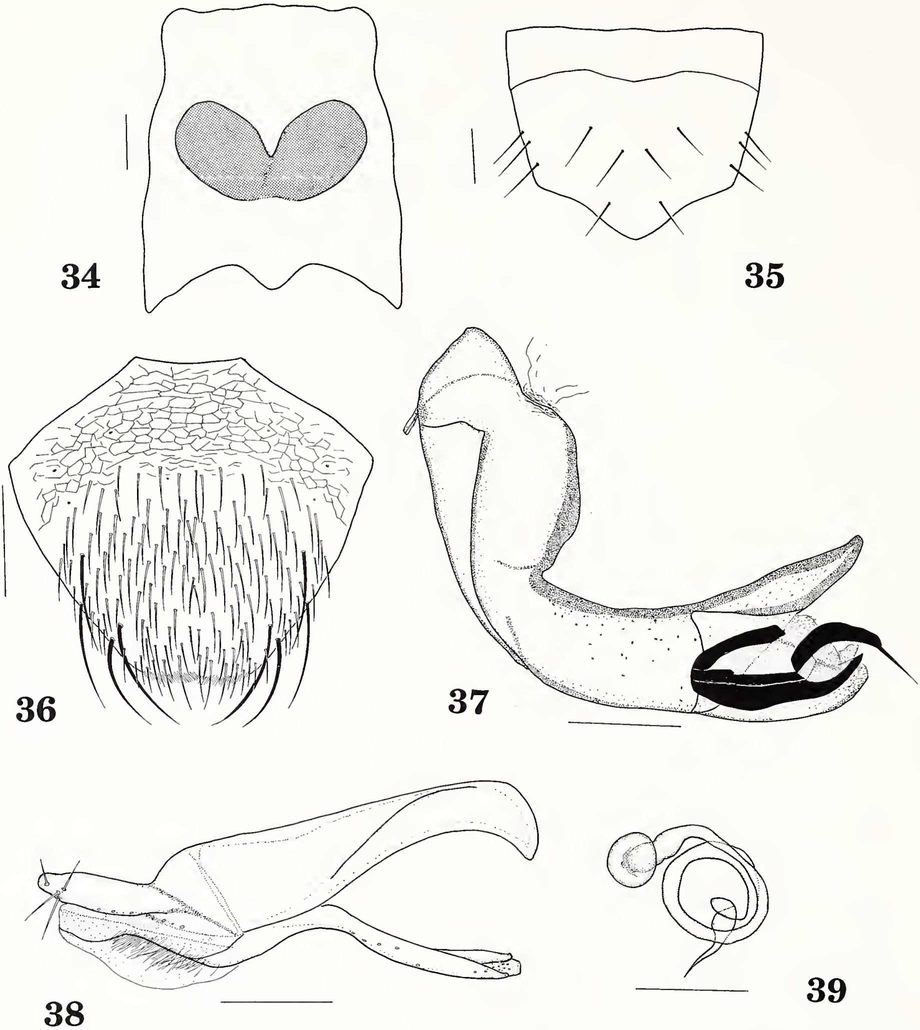


Figs. 27–33. *Paramblopusa borealis* Casey. 27, Antenna, dorsal aspect; 28, Labrum, dorsal aspect; 29, Epipharynx, dorsal aspect; 30, Mandible, ventral aspect; 31, Maxilla, dorsal aspect; 32, Mentum, dorsal aspect; 33, Labium, dorsal aspect. Scale, 0.1 mm.

macrosetae sparse, indistinct, mostly at sides. Hypomera large, entirely visible in lateral aspect. Mesocoxal cavities (Fig. 34) contiguous; mesosternal process acute. Metasternum mid-sized. Tibiae without spinules; tarsal formula 4-4-5; claws elongate and curved.

ELYTRA. Elytra 0.8–0.9 times as long as pronotum; lateral length greater than medial, microsetae numerous, directed posteriorly, uniformly distributed, macrosetae sparse, mostly at sides. Hind wings absent.

ABDOMEN. General shape broad at base, and sides uniformly converging to rounded apex; microsetae numerous, directed posteriorly, uniformly distributed; macrosetae inconspicuous, sparse. Tergites III–VII strongly impressed at base. Sternites



Figs. 34–39. *Paramblopusa borealis* Casey. 34, Mesocoxal cavities, dorsal aspect; 35, Sternite VIII of male, dorsal aspect; 36, Tergite X, dorsal aspect; 37, Median lobe, lateral aspect; 38, Paramere, lateral aspect; 39, Spermatheca, dorsal aspect. Scale, 0.1 mm.

III–VII constricted at base. Tergite X (Fig. 36) with 4 pairs of distinct major setae and numerous unsclerotized additional setae.

SECONDARY SEXUAL CHARACTERISTICS. Sternite VIII (Fig. 35) of male prolonged posteriorly as a broad triangular projection. Female unmodified.

AEDEAGUS. Median lobe (Fig. 38). Paramere (Fig. 39).

SPERMATHECA. (Fig. 37) Long, slender, coiled.

Type Species. *A. borealis* Casey, by monotypy.

Distribution. From Alaska to Oregon.

Remarks. *A. borealis* Casey has been included in the genus *Amblopusa* with *A. brevipes* Casey because members of the two species superficially resemble each other. However, cladistic analysis (Ahn and Ashe, in press) indicates that *A. borealis* is not part of a monophyletic lineage with other species of *Amblopusa.* Instead *A. borealis* is sister group to the species of *Liparocephalus* and *Diaulota* and together with these two genera form the sister group to the other members of *Amblopusa.* Consequently, it must be classified under a different generic name. Therefore, we have described the new genus *Paramblopusa* to contain *A. borealis,* which is characterized by two apomorphic features: triangular mentum with deeply incised V-shaped emargination at apex and teeth present between mandibular apex and median tooth.

Paramblopusa borealis (Casey), **new combination**

Amblopusa borealis Casey, 1906: 355; Bernhauer and Scheerpeltz, 1926: 550; Moore, 1956: 128; Hatch, 1957: 149; Moore and Legner, 1975: 339.

Description. Length 2.5–3.4 mm. Body color variable: dark brown, reddish brown, brown, or light brown.

Head about 0.9 times as long as wide. Ratio of length of compound eyes to length of head ≈ 0.2. Antennomeres (Fig. 27) 4–10 almost moniliform. Labrum (Fig. 28) slightly sinuate anteriorly, no sensilla on anterior margin, punctures more or less uniformly distributed. Mandible (Fig. 30) with 4 small teeth between apex and median tooth. Labial palpi (Fig. 32) with 3 articles, 2 and 3 subequal in length, and slightly longer than 1, each much narrower than preceding; twin pores and median pores absent, prementum with several pseudopores medially and laterally, basal pores and setal pores not apparent. Mentum (Fig. 33) triangular, deeply incised with V-shaped emargination at apex, with several long setae. Submentum with numerous deep punctures. Pronotum subquadrate. Lengths of anterior and middle tarsomere 4 subequal to tarsomeres 1 + 2 + 3 together. Elytra ≈ 1.4 as long as wide; ≈ 0.8–0.9 times as long as pronotum. Anterior margin of abdominal tergites III–VI straight.

AEDEAGUS. Median lobe (Fig. 38). Paramere (Fig. 39).

SPERMATHECA. (Fig. 37).

Type Series. Lectotype, male, here designated, in the National Museum of Natural History, Washington, D.C., with labels as follows: 'Casey bequest 1925; Lectotype, *Amblopusa borealis* Casey, Desig. K. J. Ahn and J. S. Ashe, 1994.' Paralectotype, 1, same data as lectotype except for 'Metlakatla, B. Col., Keen.'

Material Examined. CANADA: British Columbia: Massett (CAS, 4); Caspaco, Skeena River Estuary, 11 Aug. 1973, G. Schulte (KSEM, 2); Beaver Harbor, 13 Sept. 1970, W. G. Evans (KSEM, 2). UNITED STATES: Alaska: Saldovia, 11 July 1899, T. Kincaid (MCZ, 1); Unalaska, Dutch Harbor, 9 July 1907, Van Dyke (CAS, 6); 29 June 1907, Van Dyke (CAS, 2); Valdez, 1 Aug. 1978, P., P.-H., Madaline & S. Arnaud (CAS, 2); Haines, Port Chilkoot, 7 Aug. 1973, G. Schulte (KSEM, 1); Prince William Sound, Sawmill Bay, 4 Aug. 1973, G. Schulte (KSEM, 2); Homer, Coal Bay, 24 May 1994, K. J. Ahn (KSEM, 19); Seward, 25 May 1994, K. J. Ahn (KSEM, 2); Arrandale Cannery, Chatham Sd., 8 Aug. 1946, E. F. Ricketts (FMNH, 2); Red Bay, Prince of Wales Isl., 13–14 Sept. 1951, B. Malkin, tide flats under rocks (FMNH, 2); Kah Sheets Bay, Kupreanof Isl, 31 Aug. 1951, B. Malkin, Tide

Table 1. The differences between members of the genera *Amblopusa* Casey and *Paramblopusa* Ahn and Ashe.

	Amblopusa	*Paramblopusa*
Shape of median tooth of right mandible	Not triangular	Triangular
Teeth between mandibular apex and median tooth	Absent	Present
Shape of mentum	Not triangular	Triangular, deeply incised with V-shaped emargination at apex
Anterior margin of abdominal tergites III–VI	Deeply and broadly V-shaped	Straight
Apical lobe of paramere	More or less diamond-shaped	Long

flats under rocks (FMNH, 7). Washington: Kitsap Co.: Bainbridge Is., 13 Oct. 1974, D. Giuliani (UCR, 3); Oregon: Lincoln Co.: Newport, Yaquina Estuary, 22 Aug. 1973, G. Schulte (KSEM, 7); Coos Co.: Coos Bay, East Side, 26 Aug. 1973, G. Schulte (KSEM, 2).

Distribution. From Alaska to Oregon.

DISCUSSION

Casey (1893) placed *Amblopusa* in Bolitocharides based on the 4-4-5 tarsal formula and 11-articled antennae. He noted that *Amblopusa, Diaulota,* and *Liparocephalus* could be a well isolated group of genera among Bolitocharides based on inhabiting the Pacific coast, elytra very short, tibiae short, devoid of lateral spinules, long sparse hairs present, and tarsi very short.

Fenyes (1918), who next mentioned *Amblopusa,* placed it in the tribe Bolitocharini (group Liparocephali) based on the number of the tarsal joints (4-4-5), the number of antennal articles (11), and the number of segments of the maxillary (4), and labial palpi (2 or indistinctly 3).

Bernhauer and Scheerpeltz (1926) and Hatch (1957) likewise classified the genus based on Casey's description and Fenyes's placement.

Chamberlin and Ferris (1929) compared the structure of members of *Amblopusa, Diaulota,* and *Liparocephalus* and concluded that *Amblopusa* is congeneric with *Diaulota.* However, Moore (1956) revealed that they incorrectly identified *D. vandykei* as *A. brevipes.* He placed *Amblopusa* in the subtribe Phytosi and made mention of the systematic relationships of the genus *Amblopusa* among the Phytosi.

The latest mention of the aleocharine genus *Amblopusa* was by Seevers (1978). He removed the subtribe Phytosina from the tribe Bolitocharini and raised it to tribal status (tribe Phytosini) and placed *Amblopusa* in the tribe Phytosini based primarily on tarsal formula (4-4-5), elytra shorter than pronotum, and hind wings absent.

From the time of its description, *Amblopusa* Casey has been consistently classified with a number of other intertidal aleocharine genera in the tribe Phytosini, or its equivalent.

We compared the structure of members of *Amblopusa* to that of members of several intertidal phytosine genera. Our comparative examination revealed that both *Amblopusa* and *Paramblopusa* are well-supported monophyletic group. However, cladistic analysis (Ahn and Ashe, in press) indicates that members of *Paramblopusa* is not part of a monophyletic lineage with other species of *Amblopusa.* Instead they are sister group to the species of *Liparocephalus* and *Diaulota* and together with these two genera form the sister group to the other members of *Amblopusa.*

The differences between members of the genera *Amblopusa* and *Paramblopusa* are presented in Table 1.

ACKNOWLEDGMENTS

We thank the following individuals and institutions for their contributions of this project. California Academy of Sciences (CAS; D. Kavanaugh), Field Museum of Natural History (FMNH; A. F. Newton), Museum of Comparative Zoology (MCZ; D. G. Furth), National Museum of Natural History (NMNH; G. N. House), Snow Entomological Museum of the University of Kansas (KSEM), and University of California at Riverside (UCR; S. I. Frommer), generously provided us with the opportunity to examine the collections including type series of species of *Amblopusa* and *Paramblopusa* by arranging for the loan of specimens. This research was supported by Univ. of Kansas General Research Fund Award # 91-162, NSF Grant DEB–9521755 (James S. Ashe) and Snow Entomological Museum Development Fund.

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A NEW SPECIES OF *AUSTROTINODES* (TRICHOPTERA: ECNOMIDAE) FROM TEXAS

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Abstract.—*Austrotinodes texensis,* new species, from the Edwards Plateau region of Texas, is described and illustrated. The new species appears most closely related to *Austrotinodes sedmani* Flint from Central America, but differs primarily in the aedeagus having only two pairs of lateral processes and in the shape of the intermediate appendages. The genus now is represented in North America by five species. A checklist of the 34 known species of *Austrotinodes* and their distributions is presented.

The genus *Austrotinodes* Schmid previously consisted of 33 species that are distributed primarily in Mexico and southward throughout Central and South America (Schmid, 1955; Flint, 1973; Flint and Denning, 1989; Muñoz and Holzenthal, 1993). However, Waltz and McCafferty (1983) reported finding an unidentified *Austrotinodes* larva from central Texas. Recent collections of caddisflies from Texas yielded adult and immature specimens of *Austrotinodes* that represent an undescribed species. Herein, the new species is described and illustrated. Terminology follows Flint and Denning (1989). Type specimens are deposited in the California Academy of Science (CAS), Florida State Collection of Arthropods (FSCA), Illinois Natural History Survey (INHS), National Museum of Natural History (NMNH), Texas A & M University Entomology Collection (TAMU), University of Minnesota Insect Collection (UMSP), University of North Texas Insect Collection (UNT), and the Royal Ontario Museum (ROM). All material is stored in 70% ethanol.

Austrotinodes texensis, new species
Figs. 1–16

Male. Figs. 1–4. Forewing 4.5 mm, hindwing 4.0 mm. Wings brown with patches of fine, light brown setae near costal margin. Abdomen tan with brown sclerites. Legs and thoracic sclerites light brown. Head brown with dark brown setae, antennae cream-white. *Genitalia.* Segment IX deeply divided with sternum elongated; in ventral view, approximately 2 times as long as wide, with lateral margins sinuate; in lateral view, broad preapically. Inferior appendages robust, fused mesally, with prominent mesal emargination in ventral view. Phallic guide darkly sclerotized, strongly arched, tip blunt. Intermediate appendages long and narrow throughout length in lateral view, but each with prominent, rounded mesal arch at mid-length in dorsal view, distal half divergent, bearing three stout apical setae. Tergum X divided into pair of semi-membranous oval lobes lying between bases of preanal appendages. Preanal appendages long, tapering apically, apex rounded, margins crenulated, surface setose. Aedeagus sclerotized basally and membranous apically; bearing two

pairs of processes originating dorso-laterally, tips of processes convergent in dorsal view.

Female. Fig. 5. Forewing 5.5 mm, hindwing 5.0 mm. Coloration as in male. *Genitalia.* Eighth segment with sternum prolonged posteriad gradually tapering to broad point, about 1.5 times long as wide. Ninth segment greatly prolonged, narrow, compressed tube bearing setae. Tenth segment elongate, narrow, with three pairs of apical papillae.

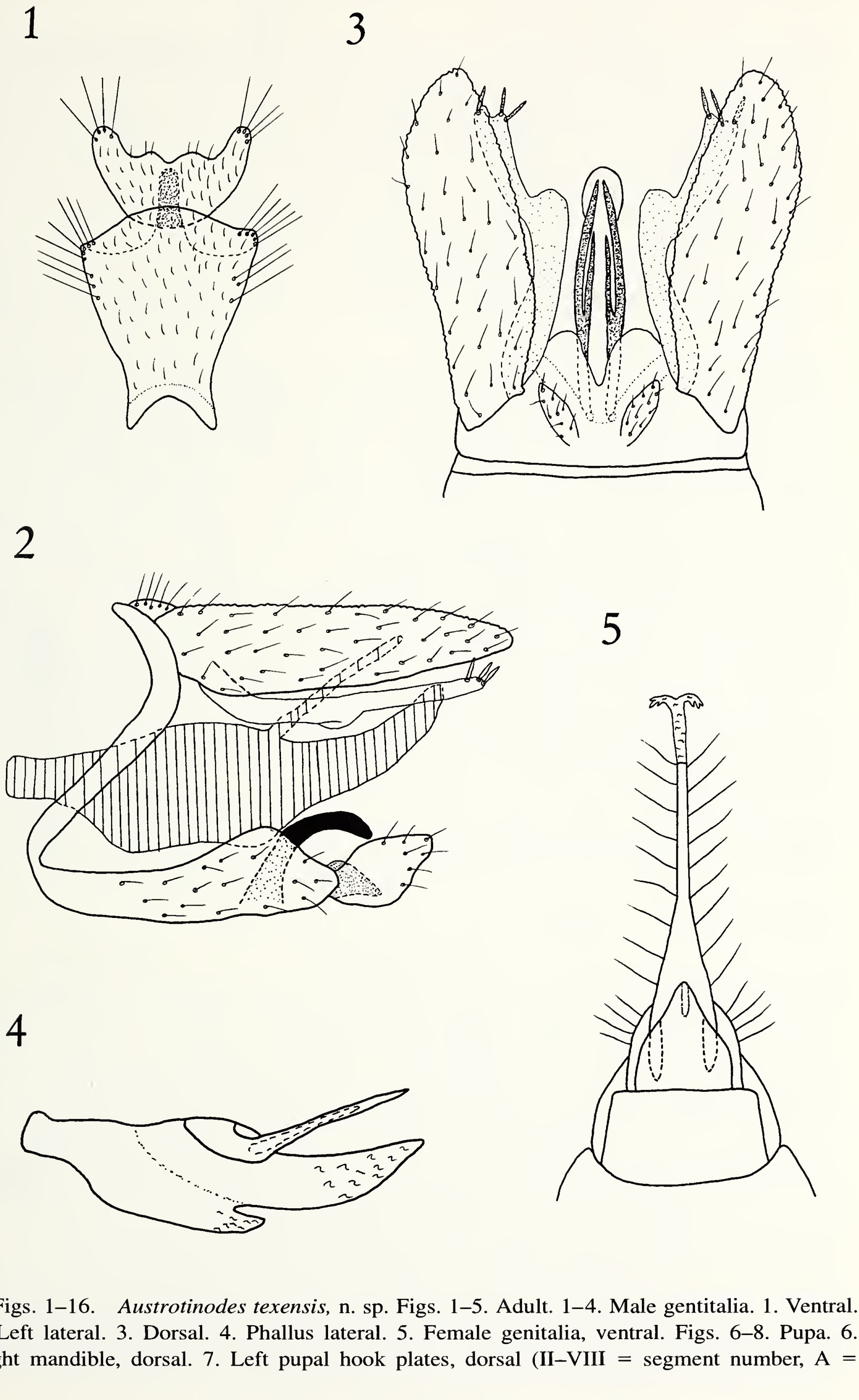
Pupa. (female, genitalia visible). Figs. 6–8. Length 6.1 mm. Mandibles elongate, curved, without serrations. Labrum semicircular; with four setae laterally on anterior margin and three long setae laterally on each side of basal section. Antennal scapes each with two long setae; antennae extending to abdominal segment VII. Tarsus of each metathoracic leg with dense fringe of hairs. Wing pads reaching fifth abdominal segment. Abdominal segments each bearing four pairs of setae dorsally (three pairs posteriorly, one pair anteriorly) that become increasingly longer toward eighth segment; segments II–VIII bearing four setae laterally. Hook plates present anteriorly on segments II–VIII, segment V with both anterior and posterior hook plates. Apical process a small lobe bearing several long setae.

Larva. Figs. 9–16. Length 7.0 mm. Head, pronotum and forelegs reddish-brown; mesonotum and metanotum and hindlegs yellow; abdomen whitish. Head elongate and depressed, nearly two-thirds the length of the thorax, broadest posteriorly; with a prominent ventro-lateral carina from eyes posteriorly; with only primary setae. Frontoclypeus elongate and parallel-sided, with anterior margin nearly straight, Labrum sclerotized, lacking secondary setae or brushes; inner surface with a row of prominent, basally directed, spine-like setae. Mandibles long and slender; with dorsal cutting edge overhanging ventral edge, left mandible deeply concave between cutting edges. Maxillae with palpifer and galea elongate; each palpus with basal two segments short, third elongate, fourth about one-third as long as third; labium with elongate mesal lobe, each palpus long and slender. Thoracic nota sclerotized; median ecdysial line absent; posterior margins of each notum partially recessed into the anterior margin of each succeeding notum. Pronotum with numerous primary setae and few secondary setae; lacking sulcus. Each propleuron fused to its trochantin which is elongate and narrow in lateral aspect but rather broad in dorsal view, and with prominent apico-dorsal notch. Meso- and metanota sclerotized, divided longitudinally on midline, with few secondary setae. Forelegs heavily sclerotized; each with coxa elongate, broad, bearing stout black setae apically. Mid- and hindlegs more lightly sclerotized than forelegs; coxae of midleg each bearing moderately stout black setae mesally. Hindlegs each with scattered setae on trochanter, femur, tibia, and tarsus modified into short, enlarged spines; claw slender and straight. Abdomen with only scattered primary setae; anal papillae present. Anal prolegs each with basal membranous section lacking setae; claw large, evenly curved and tapered, its ventral margin without teeth.

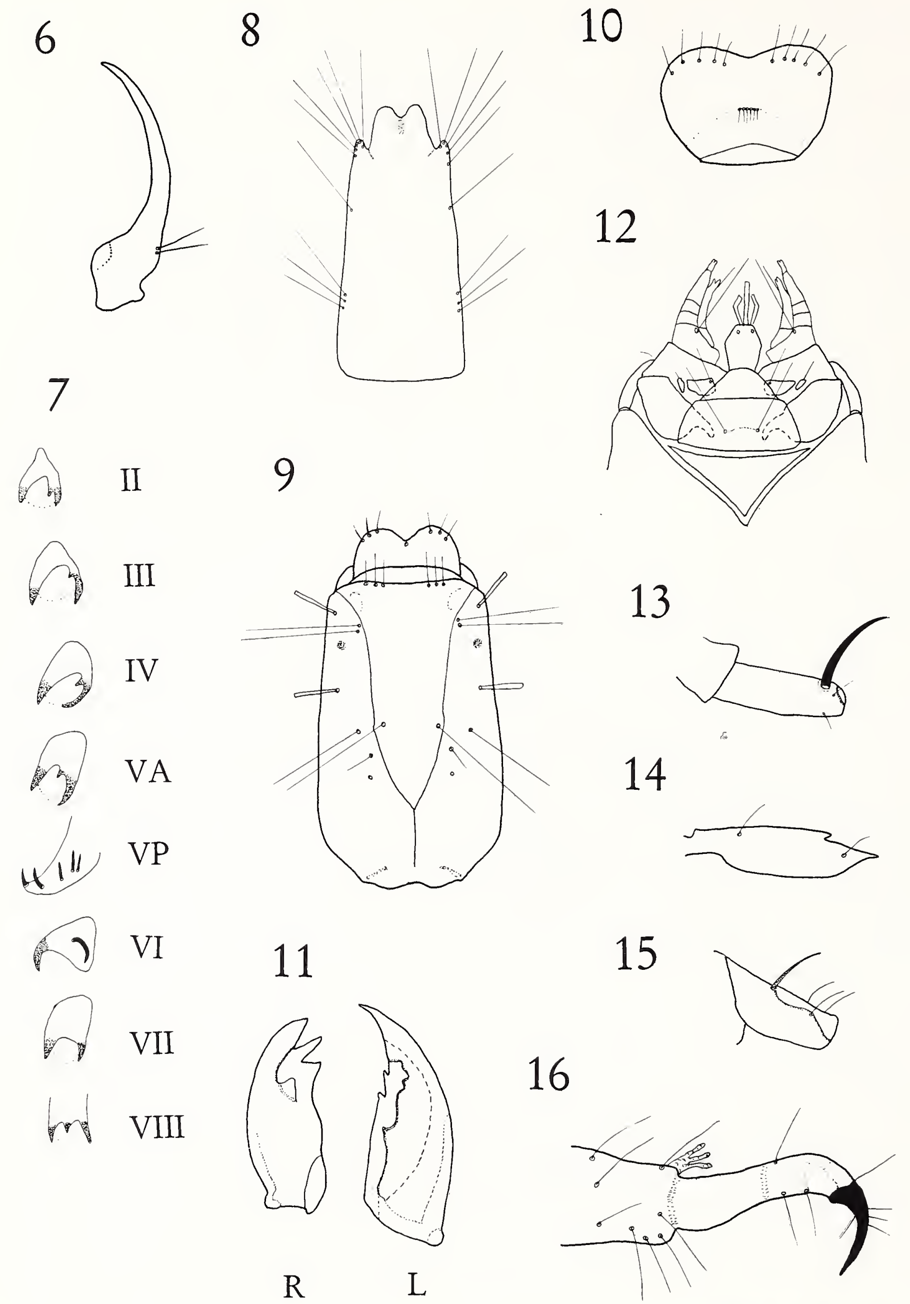
Holotype. Male, USA, Texas, Bandera Co., 1 mi N Medina, Hwy. 16, Medina River, 9 May 1992, D. E. Bowles, aspirated (NMNH).

Allotype. Female, same data as holotype, but 4 May 1992 (NMNH).

Paratypes. Same data as holotype, but 29 May 1991, aspirated, 1 male (ROM); 8 Jun 1991, aspirated, 1 female (ROM); 26 Apr 1992, aspirated, 1 female (NMNH); 4 May 1992, aspirated, 2 males (UMSP, INHS); 1 female (UMSP), 4 May 1992,



Figs. 1–16. *Austrotinodes texensis,* n. sp. Figs. 1–5. Adult. 1–4. Male gentitalia. 1. Ventral. 2. Left lateral. 3. Dorsal. 4. Phallus lateral. 5. Female genitalia, ventral. Figs. 6–8. Pupa. 6. Right mandible, dorsal. 7. Left pupal hook plates, dorsal (II–VIII = segment number, A =



anterior, P = posterior). 8. Apex of abdomen, dorsal. Figs. 9–16. Larva. 9. Head, dorsal. 10. Labrum, ventral. 11. Mandibles, ventral (R = right, L = left). 12. Head, ventral. 13. Coxa of right foreleg. 14. Right trochantin, lateral. 15. Coxa of right midleg. 16. Left anal proleg, lateral.

UV-light, 9 females (5—NMNH, 2—ROM, 2—TAMU); 9 May 1992, aspirated, 3 males (FSCA, NMNH, TAMU). Same data, but 3 mi NW Medina, 29 May 1991, UV-light, 1 female (CAS); 10 Jun 1991, UV-light, 6 females (FSCA); 26 Jun 1991, UV-light, 4 females (2—INHS, 2—TAMU). Real Co., Frio River, Leakey, 9 Jun 1994, R. Gorano, 2 males (CAS, UNT), 1 female (UNT). Val Verde Co., Del Rio, San Felipe Springs, 20 Apr 1992, D. E. Bowles, aspirated, 1 female (TAMU).

Other Material. Same data as holotype, but 9 May 1992, 1 larva (ROM), 27 Feb 1993, 1 larva (NMNH). Hays Co., Little Arkansas/Fern Bank springs, ca. 8 km E Wimberly, 11–14 August 1992, C. B. Barr, drift net, 1 pupa (NMNH).

Etymology. Named for the state of Texas to which this species appears to be endemic.

Remarks. *Austrotinodes texensis* is related to the species-groups of Central America and Mexico having the hindwings reduced in size with the corresponding loss of one anal vein, and the absence of ventral teeth on the anal claw of the larva (Flint 1973).

The new species is closely related to *Austrotinodes sedmani* Flint from Central America. However, males of *A. sedmani* from Panama that I examined showed the intermediate appendages in dorsal view were much broader distally, did not arch as abruptly as in the new species, and were more angular at midlength compared to the rounded condition observed in *A. texensis* (see Muñoz and Holzenthal, 1993, Fig. 5). Also, the inferior appendage in ventral view is considerably more robust in the new species, and the lateral margins of the ninth sternum in *A. sedmani* are relatively straight in comparison to the more sinuate margins in *A. texensis.*

A comparison of the female of the new species with the allotype female of *A. sedmani* also suggests they are closely related differing primarily in the shape of the eighth abdominal sternum. In *A. sedmani* this structure is small and is slightly wider than long, but in the new species the eighth sternum is considerably larger, being nearly 1.5 times long as wide.

Although the larva and pupa of the new species differ morphologically from those illustrated by Flint (1973), these lifestages are known for so few species in the genus that meaningful comparison is impossible.

BIOLOGICAL NOTES

The collection of the three larvae mentioned here (one by Waltz and McCafferty, 1983) are the only known larvae collected for the genus *Austrotinodes* in North America. Flint's (1973) larval description was based on prepupae that were collected from the undersides of rocks in a sandy, rocky stream in Chile. Flint suggested that, because of the odd stucture of the legs and the rather hairless appearance of the body, the larvae probably are tube-dwellers in the sand or gravel of the stream bottom or on rocks and large boulders. The larvae I collected were taken from deep pools (1.5–2.0 meters) of the Medina River where the substrate is coarse. The larvae were collected by digging deep into the substrate and then sifting the excavated materials. Extensive collecting in riffle areas did not yield any specimens. This suggests that Flint's proposal of a tube-dwelling larval form probably is correct. Nothing else is known about the biology of this species in the aquatic habitat.

Austrotinodes texensis appears to be endemic to the karst springs and/or spring-runs of the Edwards Plateau region of Texas (Bowles and Arsuffi, 1993). The Medina

Table 1. The species of *Austrotinodes,* including their geographic locations. Records are based on Schmid (1955), Flint (1973). Flint and Denning (1989), and Muñoz and Holzenthal (1993).

Species	Location
Austrotinodes amazonensis Flint and Denning, 1989	Brazil
A. ancylus Flint and Denning, 1989	Ecuador
A. angustior Schmid, 1955	Chile
A. ariasi Flint and Denning, 1989	Brazil
A. armiger Flint, 1983	Chile
A. bracteatus Flint and Denning, 1989	Brazil
A. brevis Schmid, 1989	Chile
A. canoabo Flint and Denning, 1989	Venezuela
A. cekalovici Flint, 1969	Chile
A. chihuahua Flint and Denning, 1989	Mexico
A. contubernalis Flint and Denning, 1989	Costa Rica, Panama
A. cubanus Kumanski, 1987	Cuba
A. doublesi Muñoz and Holzenthal, 1993	Costa Rica
A. fortunata Flint and Denning, 1989	Panama
A. freytagi Flint and Denning, 1989	Belize, Honduras
A. fuscomarginatus Flint and Denning, 1989	Venezuela
A. inbio Muñoz and Holzenthal, 1993	Costa Rica
A. irwini Flint, 1973	Chile
A. lineatus (Navas), 1934	Chile
A. mexicanus Flint, 1973	Mexico
A. neblinensis Flint and Denning, 1989	Venezuela
A. nielseni Flint and Denning, 1989	Argentina
A. panamensis Flint, 1973	Costa Rica, Panama
A. paraguayensis Flint, 1983	Brazil, Paraguay
A. picada Flint, 1983	Chile
A. prolixus Flint and Denning, 1989	Brazil
A. quadrispina Schmid, 1958	Chile
A. recta Schmid, 1964	Argentina, Chile
A. recurvatus Flint, 1983	Chile
A. sedmani Flint, 1973	Costa Rica, Panama, British Honduras, Guatemala
A. talcana (Navas), 1934	Chile
L. triangularis Schmid, 1958	Chile
A. texensis, new species	United States
A. tuxtlensis Flint and Denning, 1989	Mexico

River, the type locality, has its origin in several small springs in Bandera County, Texas, where it flows through the Texas Hill Country. The stream normally flows year round although the water level can drop appreciably during periods of little precipitation. Flow in the Medina River is swift over a coarse substrate. Few macrophytes are present but include watercress (*Rorippa nasturtium-aquaticum* (L.). Substrate ranges from cobble and gravel to limestone bedrock. The banks are lined with large bald cypress (*Taxodium distichium* (L.)) with Spanish and ball moss (*Til-*

landsia usneoides (L). and *T. recurvata* (L.), respectively). Numerous limestone outcroppings are present along the stream. The nearby Frio River, also a collection site for the new species, is similar in many respects to the Medina River. An analysis of the chemical composition and variability of the waters of the Frio and Medina rivers was presented by Groeger and Gustafson (1994). They found both streams had high specific conductance which is typical of streams flowing through the karst areas of the Edwards Plateau in Central Texas. The median specific conductance of the Medina River was 530 μS/cm while that of the Frio River was 400 μS/cm (Groeger and Gustafson, 1994). Both streams had high levels of Ca, Mg, and SO_4 indicating limestone weathering. The high ionic content of the Medina River also suggests an exposure of anhydrite and gypsum (Groeger and Gustafson, 1994).

The new species also was collected at San Felipe Springs in Val Verde County near the Rio Grande. These springs are the fourth largest springs in Texas with an average annual discharge of 2,600 L s^{-1} and have never been reported dry (Brune, 1981). The other collection site, Fern Bank Springs in Hays County, also have never been reported dry, but are considerably smaller than either the Medina River or San Felipe Springs. The flow of Fern Bank Springs varies, but usally does not exceed 140 L s^{-1}. These springs flow approximately 20 m before joining the Blanco River.

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TAXONOMIC CHANGES IN ORIENTAL FULGOROIDEA (HEMIPTERA: FULGOROMORPHA)

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Abstract.—*Guentheria formosa* Lallemand is transferred from the Phenacinae of the Fulgoridae to the Eurybrachidae. *Hellerides* Lallemand of the Limoisini of the Aphaeninae of the Fulgoridae is synonymised with *Zophiuma* Fennah of the Lophopidae. Two new specific combinations *Z. guineae* (Lallemand) and *Z. butawengi* (Heller) are established.

Examination of several fulgoroid genera revealed that *Guentheria* Lallemand, previously described in the Phenacinae of the Fulgoridae, is a member of the Eurybrachidae and *Hellerides* Lallemand, previously described in the Limoisini of the Aphaeninae of the Fulgoridae, is a new synonymy of *Zophiuma* Fennah of the Lophopidae. The purpose of the present paper is to report these taxonomic changes.

EURYBRACHIDAE

Guentheria Lallemand, **New Placement**

Guentheria Lallemand, 1963: 6. Type species: *Guentheria formosa* Lallemand, 1963: 6, by original designation and monotypy. Referred from Fulgoridae: Phenacinae.

Discussion: *Guentheria* was established by Lallemand (1963) in the Phenacinae of the Fulgoridae to contain a single species *G. formosa* from southern China. Since then, neither the genus nor species has been mentioned in the literature. My examination of three new specimens clearly identifiable as *G. formosa* indicates that *Guentheria* is actually a member of the Eurybrachidae. I am here transferring *Guentheria formosa* Lallemand from the Phenacinae of the Fulgoridae to the Eurybrachidae on the basis of the following characters: (1) eyes spinose beneath; (2) frons broad, broader than long, without median carina, the lateral margins angulate near middle; (3) clypeus without lateral carinae; (4) rostrum flat and short, not extending beyond the hind trochanters, apex bisulcate; (5) antennal pedicel relatively small and with few sensory organs; (6) pronotum short; (7) anterior coxae short, anterior trochanters near the postclypeus; (8) anterior and middle femora and tibiae compressed, more or less dilated; (9) the second hind tarsomere small, without apical spines; and (10) the females have large leaf-like wax plates.

At present, only female specimens of *G. formosa* are available. It is necessary to study the structures of the male genitalia to establish the correct status of the *Guentheria* within the Eurybrachidae.

Guentheria formosa Lallemand

Guentheria formosa Lallemand, 1963: 6.

Discussion: Lallemand (1963) originally described *Guentheria formosa* from a single female taken at Canton, Guangdong Province in southern China. I have found three females of this species from Fujian Province in southeastern China.
Distribution: China (Guangdong and Fujian Provinces).
Specimens Examined: CHINA, FUJIAN PROVINCE: 1♀, Jiangle, Mt. Longxishan, 18.x.1991 (C. M. Huang); 1♀, same locality, but 840 m, 22.vi.1991 (L. L. Yang); 1♀, same locality, but 850 m, 24.vi.1991 (W. C. Ma) (all in the Insect Collection of the Institute of Zoology of the Chinese Academy of Sciences, Beijing, China).

LOPHOPIDAE

Zophiuma Fennah

Zophiuma Fennah, 1955: 170. Type species: *Acarna pupillata* Stål, 1863, by original designation.
Hellerides Lallemand, 1962: 1; 1963: 56. Type species: *Hellerides guineae* Lallemand, 1962, by original designation and monotypy. **New Synonymy.**

Discussion: *Zophiuma* was established by Fennah (1955) for *Acarna pupillata* Stål (1863: 586) (type species) and *Kasserota doreyensis* Distant (1906: 350) in the Lophopidae. Ghauri (1967: 557) added the third species *Z. lobulata.*

Lallemand (1962) proposed the new genus *Hellerides* to contain *H. guineae* in the Limoisini of the Aphaeninae of the Fulgoridae. Heller (1966) added the second species *H. butawengi.* A careful reading of both Lallemand's (1962) and Heller's (1966) original descriptions and illustrations shows that both *H. guineae* Lallemand and *H. butawengi* Heller are typical members of *Zophiuma* and that *Hellerides* Lallemand is a new synonym of *Zophiuma* Fennah.

The two species transferred from the *Hellerides* increases the total number of the species of *Zophiuma* to five. They are all described from New Guinea. Further studies may show some new specific synonymies.

Zophiuma guineae (Lallemand), **New Combination**

Hellerides guineae Lallemand, 1962: 3, figs. 1–6; 1963: 56.

Discussion: This species was described from a single female collected from New Guinea. Lallemand (1962) gave detailed original description and adequate illustrations. The original description and illustrations clearly show that *guineae* belongs in *Zophiuma.*
Distribution: New Guinea.

Zophiuma butawengi (Heller), **New Combination**

Hellerides butawengi Heller, 1966: 1, figs. 1–6.

Discussion: This species was adequately described and illustrated by Heller (1966) from a single female taken in New Guinea. The original description and illustrations clearly show that it belongs in *Zophiuma.*

Distribution: New Guinea.

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DOLICHOVESPULA (HYMENOPTERA: VESPIDAE), HOSTS OF *APHOMIA SOCIELLA* (L.) (LEPIDOPTERA: PYRALIDAE)

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Abstract.—Caterpillars of the moth *Aphomia sociella* (L.) were collected from active colonies of *Dolichovespula arenaria* (F.) and *D. maculata* (L.), the first documented new world hosts for this nest inquiline. Caterpillars held indoors were successfully reared to adults. Emergences coincided with typical flight period ranges in nature, overlapping the early phases of vespine colony development.

The bumble bee wax moth *Aphomia sociella* (L.) is an inquiline of bumble bee and vespine wasp colonies. It is widely distributed in Europe, where its life cycle, habits, and host range have been described (Sladen, 1912; Beirne, 1952; Kemper and Dohring, 1967; Pouvreau, 1967; Alford, 1975). Larvae developing within the host nest may consume nest materials, stored food, meconia and other wastes, and immature stages of the host insect. The silken webbing, tunnels, and cocoons spun by *A. sociella* caterpillars are dense and difficult to penetrate. Heavy infestations at vespine colonies can destroy large areas of comb (Fig. 1)

In North America, published reports refer only to the distribution of adults (Forbes, 1923), and specific host records are lacking. In the present study I document the occurrence of *A. sociella* caterpillars in active colonies of two *Dolichovespula* Rohwer species, and offer additional notes on its habits and distribution.

MATERIALS AND METHODS

Nests of potential vespine hosts of *A. sociella* from two regions of North America were examined. From 1984–1988, 131 nests were collected from Alameda, Contra Costa, and San Francisco Counties, California. From 1992–1994, 108 nests were collected from Dutchess, Putnam, and Westchester Counties, New York, and Fairfield County, Connecticut. Each nest was removed from its natural setting, its envelope stripped, and combs separated to search for *A. sociella* caterpillars or webbing. Five infested nests were held in clear plastic containers for up to two weeks to allow adult wasps to eclose. Caterpillars and the associated matrix of webbing and nest materials were then transferred to cardboard cans (i.e., not exposed to light) and held indoors at approximately 10°C to rear adults moths.

The area around an incandescent night light at Brewster (Putnam County), New York was inspected for alighted adults during evenings from April to November in 1992–1994. Adult specimens in the collections of The American Museum of Natural History and Cornell University were examined for additional distributional and phenological data.

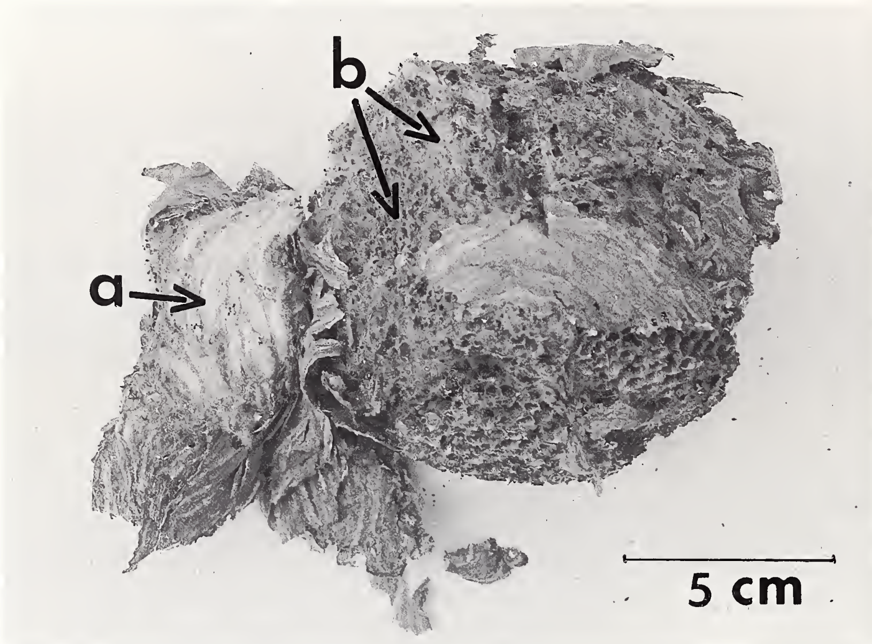

Fig. 1. *Dolichovespula arenaria* nest dissected by *Aphomia sociella* caterpillars. Nest envelope has been removed to show interior: a—mass of *A. sociella* coccons; b—upper combs engulfed in matrix of silk webbing; small dark spots scattered throughout are caterpillar feces.

RESULTS AND DISCUSSION

No *A. sociella* were detected in California, a finding corroborated by previous surveys of Pyralidae in that state (J. Powell, pers. comm.). In the east, one adult female was collected at Brewster on 25 June 1993. *A. sociella* caterpillars were found only in nests of *Dolichovespula arenaria* (F.) and *D. maculata* (L.) (Table 1), rep-

Table 1. Colonies of Vespinae examined for *A. sociella*.

	Number examined	Number infested
California (1983–1987)		
Dolichovespula arenaria	65	0
Vespula pensylvanica	36	0
Vespula vulgaris	30	0
New York/Connecticut (1992–1994)		
Dolichovespula arenaria	44	6
Dolichovespula maculata	59	3
Vespula flavopilosa	3	0
Vespula maculifrons	2	0

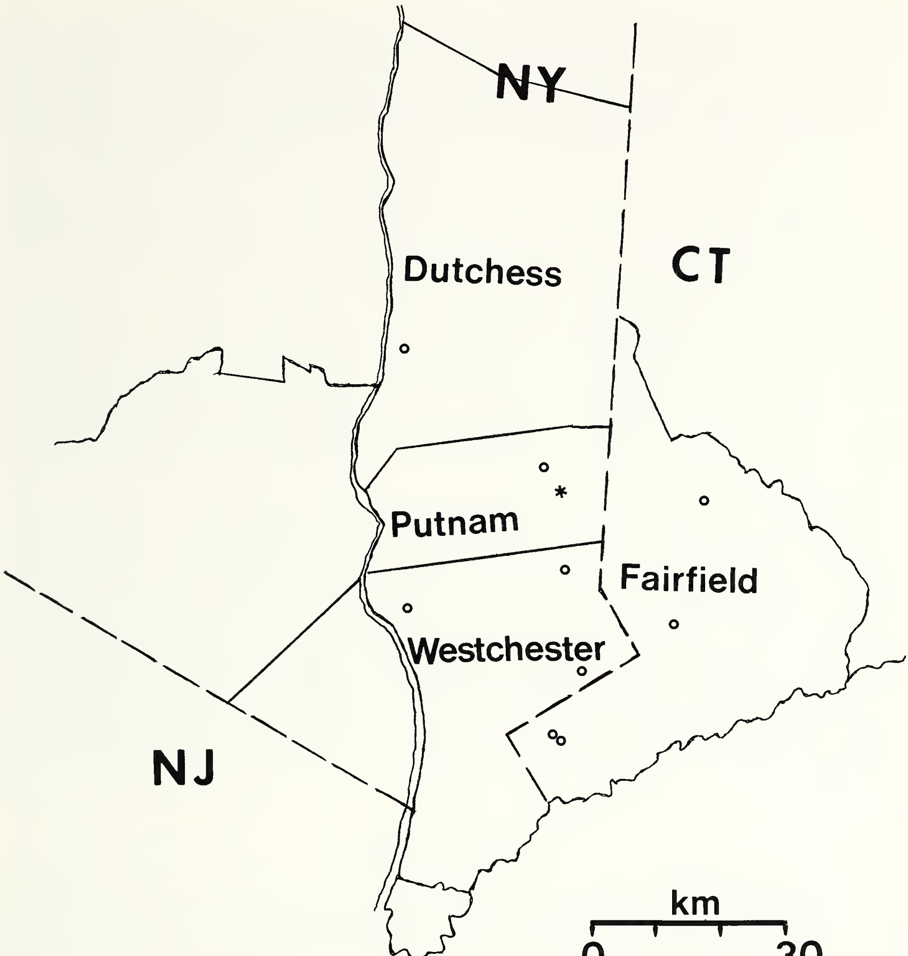

Fig. 2. Collection localities for *Aphomia sociella*; open circles represent infested *Dolichovespula* colonies; asterisk represents adult moth.

resenting the first new world host records as well as new distribution records for New York State (Fig. 2). Data are inconclusive regarding *Vespula* Thomson spp. as hosts, due to the small sample size from New York and Connecticut.

In Europe it is unusual for *A. sociella* to occur in subterranean *Bombus* nests (Beirne, 1952; Alford, 1975). This pattern, if extended to *A. sociella*'s selection among potential vespine hosts, would lead to specialization on *Dolichovespula,* which typically build exposed aerial nests, rather than *Vespula,* whose nests are typically subterranean or concealed (Akre et al., 1980).

Patterns of comb damage and silken webbing suggested that caterpillars were initially present in the topmost combs of infested nests. *A. sociella* is not an obligate

entomophage (Schousboe, 1980), and hosts may escape harm if contact with caterpillars is avoided. Coexistence within the nest may be accomplished if the infestation is light or occurs late in the colony cycle, since vespine wasps expand the nest downward by adding combs to the bottom, essentially abandoning the upper combs for rearing purposes after the cells have been used several times (Akre et al., 1980). Even heavy caterpillar infestations may cause little harm if vigorous colony growth has produced a nest large enough to accomodate both species. None of the infested *D. maculata* colonies, including one supporting a heavy caterpillar load, suffered apparent damage from the presence of the inquiline. In contrast, most of the *D. arenaria* colonies containing *A. sociella* caterpillars were in a weakened condition, as evidenced by invasion of active combs, low worker populations, or overall deterioration of the nest prior to the construction of large (reproductive) cells (Fig. 1). However, the role of *A. sociella* in *D. arenaria* colony failure is not clear, as colonies of this species may be weakened early in the colony cycle by invasion by the social parasite *D. arctica* (Rohwer) or usurpation struggles with other vespine queens (Greene, 1991), thus predisposing them to both premature decline and invasion by *A. sociella.*

Fragments of all nests held indoors yielded adults. In 1992–1993 (one nest) emergence was in March and April; in 1993–1994 (four nests) emergence was from April to early July. Although the developmental rates for insects held indoors were likely to differ from those experiencing natural climate conditions, the emergence of moths from the experimental nests was consistent with flight period ranges observed in the northeastern United States, coinciding with the early phases of *Bombus* and vespine colony development. Since the defenses of host colonies become more vigorous as worker populations increase during the summer, *A. sociella*'s early presence affords it an opportunity to enter and oviposit at nests while they are relatively poorly defended.

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J. Powell identified the moths and shared unpublished information on *A. sociella*'s distribution. E. Quinter and R. Hoebeke assisted in making available the collections of The American Museum of Natural History and Cornell University, respectively. The East Bay Municipal Utility District, the East Bay Regional Park District, and the University of California provided access to grounds where wasp nests were collected.

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LIFE HISTORY AND DESCRIPTIONS OF IMMATURES OF THE DICTYOPHARID PLANTHOPPER *PHYLLOSCELIS PALLESCENS* (HOMOPTERA: FULGOROIDEA)

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Abstract.—The life history of *Phylloscelis pallescens* Germar in Missouri is summarized and the egg and nymphs are described and illustrated. *P. pallescens* is univoltine, has five nymphal instars and apparently overwinters as eggs. This dictyopharid planthopper feeds exclusively on slender mountain mint [*Pycnanthemum tenuifolium* Schrad. (Lamiaceae)]. Nymphal instars can be separated by body size, number of pit-like sensoria, size of wing pads, metatibia and tarsomere spination, and number of metatarsomeres.

The four species of the dictyopharid planthopper genus *Phylloscelis* are widely distributed in the eastern and central United States (McPherson and Wilson, in press). The genus has been revised recently and the morphology of adults of each of the species illustrated and described (McPherson and Wilson, in press). One of the species, *P. rubra* Ball, was considered a pest of cranberry [*Vaccinium macrocarpon* Aiton (Ericaceae)], its biology on that host was studied in detail, and the immature stages described (Scammell, 1917; Sirrine and Fulton, 1914). Little is known about the biology of the other species of *Phylloscelis.*

Phylloscelis rubra is univoltine and laid the overwintering eggs from early September to the middle of October under their cranberry host plants (Ball, 1930; Scammell, 1917; Sirrine and Fulton, 1914). Ball (1930) recorded nymphs and adults feeding exclusively on *Lyonia fruticosa* (Michx.) G. Torr. ex B. L. Robinson (Ericaceae), while Sirrine and Fulton (1914) and Scammell (1917) found nymphs and adults feeding only on cranberry.

Phylloscelis atra Germar has been found feeding on a number of species of ericaceous shrubs in Florida (Ball, 1930), and *Coreopsis palmata* Nutt. (Asteraceae) in Missouri (Wilson, pers. comm.). Florida populations are bivoltine; the first generation is found from May to July, and the second generation from August to October; the eggs are the overwintering stage (Ball, 1930). *P. atra* occurs in three color morphs, one of which, "var." *albovenosa,* has pale yellow stripes on the black forewings. Hamilton (pers. comm.) notes that this color pattern is very similar to that of a presumably toxic leaf beetle (*Cryptocephala* sp.; Coleoptera: Chrysomelidae) he found at the same collecting site in Michigan.

Phylloscelis pennata Ball is known only from southwestern Texas (Ball, 1937). No biological information is available for this species.

Phylloscelis pallescens Germar ranges from Massachusetts and southern Ontario, south to northwestern Florida, and west to Iowa, Missouri, and Texas (Hamilton,

pers. comm.; Wilson and McPherson, 1980; Wilson et al., 1993b). This species has been recorded from cranberry bogs (Smith, 1910, in Sirrine and Fulton, 1914), a single specimen from a species of *Andromeda* (Ericaceae) in Florida (Ball, 1930), and numerous specimens from slender mountain mint [*Pycnanthemum tenuifolium* Schrad. (Lamiaceae)] in Missouri (Wilson et al., 1993b).

This study presents information on the life history of *P. pallescens* in Missouri, descriptions and illustrations of the egg and nymphal stages, and a key for separating the nymphal instars.

MATERIALS AND METHODS

Field Study. *P. pallescens* was first collected from its host plant, slender mountain mint, during the summer of 1990 at Paintbrush Prairie, Pettis Co., Missouri (Wilson et al., 1993b). Field collections were made with a modified Weedeater® leaf blower (Wilson et al., 1993c) from pure stands of *P. tenuifolium* weekly from 30 April to 15 October 1991 at various sites in Johnson and Pettis Counties, Missouri. Specimens were placed in an ethyl acetate charged killing jar, stored in 70% isopropyl alcohol, then brought back to the laboratory.

Descriptions of Immatures. Descriptions were based on 10 specimens, where possible. The 5th instar nymph is described in detail, with only major differences noted for earlier stages. Measurements are given in mm as mean ± SD. Length is measured from the apex of the vertex to the apex of the abdomen, width across the widest part of the body, and thoracic length along the mid-line from the anterior margin of the pronotum to the posterior margin of the metanotum. Eggs were obtained from field collected gravid females reared in plastic petri dishes lined with moist filter paper and with host plant clippings for feeding. Adult females were maintained in the laboratory under a 12:12 photoperiod at ca. 23°C until oviposition (usually within 48 hr after collection). Eggs were stored in 70% isopropyl alcohol. Descriptions of nymphs are based on the following field-collected specimens (I–V = nymphal instars, ♂ and ♀ = adults): MISSOURI: Johnson Co., Knob Noster State Park, K. R. McPherson collector, 4 July 1991 (1—I, 10—II, 12—III, 5—IV, 1—V), 12 July 1991 (1—III, 9—IV, 2—V), 16 July 1991 (2—III, 1—IV, 5—V), 11 September 1991 (2♂); Johnson Co., BB Hwy 0.5 mi. S of Warrensburg (Belshe farm), K. R. McPherson collector, 17 June 1991 (5—I, 5—II, 2—III, 1—IV), 24 June 1991 (1—III, 1—IV), 8 July 1991 (1—III, 5—IV), 18 July 1991 (4—IV, 8—V), 2 August 1991 (2—V, 2♂, 2♀), 13 September 1991 (1♂, 2♀); Pettis Co., Paintbrush Prairie, 9 mi. S Sedalia, S. W. Wilson collector, 10 August 1991 (2—V, 2♂), 16 August 1991 (1—V, 5♂, 1♀), 23 August 1991 (10♂, 6♀), K. R. McPherson collector, 17 September 1991 (1♂, 3♀), all specimens collected from *P. tenuifolium.*

RESULTS AND DISCUSSION

Field Study. No specimens were collected during April or May. Nymphal instars first appeared on 6 June with adults appearing on 2 August. *P. pallescens* is univoltine, and overwinters as eggs (Fig. 1). This is supported by the absence of overwintering adults or immatures in collected samples, and the presence of gravid females in collected samples during early fall.

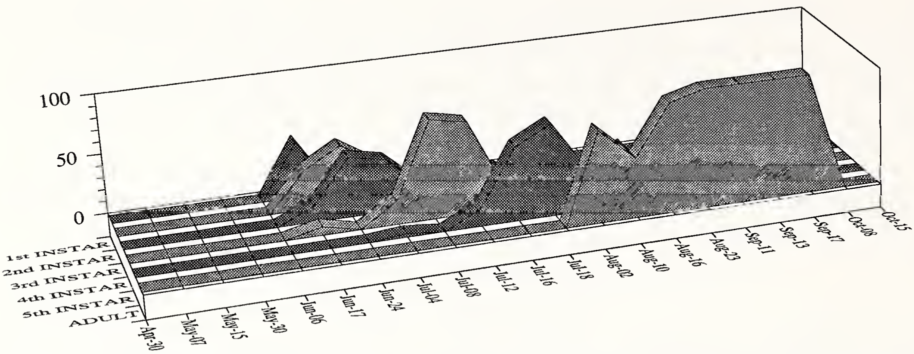

Fig. 1. Seasonal occurrence of *Phylloscelis pallescens*. Number of individuals of each stage is expressed as percentage of total observations of that stage per collecting date (N = 124; e.g., 1 third and 1 fourth instar were collected on 24 June—50% third and 50% fourth instars on that date).

This species was collected exclusively from slender mountain mint. Nymphs and adults fed on the stems of the host plant ca. 20 cm above ground level. During feeding, large amounts of wax were emitted from the abdominal waxpads of all developmental stages. This made it easy to identify, from some distance, active feeding sites and host plants. With careful maneuvering, specimens could be approached closely enough to allow collecting with an aspirator. Attempts to collect or observe this species feeding on other host plant species were unsuccessful. We believe *P. pallescens* to be host plant specific on *P. tenuifolium* in Missouri. The ranges of *P. pallescens* and *P. tenuifolium* correspond (Barkley, 1977; Grant and Epling, 1943; Wilson and McPherson, 1980; Seymour, 1969), except for specimens of *P. pallescens* from northeastern Florida (Nassau Co.) (McPherson and Wilson, in press; O'Brien, pers. comm.) where it might occur on *Pycnanthemum nudum* Nutt., which has been collected in the same county, or *P. floridanum* Grant and Epling, which has been collected in nearby counties (Judd, pers. comm.). This host plant preference corresponds to that of other dictyopharids, most of which are monophagous on dicots (Wilson et al., 1993a).

Descriptions of Immatures

Fifth Instar (Figs. 2, 3, 5). Length 3.27 ± 0.03; thoracic length 2.03 ± 0.01; width 2.63 ± 0.02. N = 10.

Form subcylindrical, convex dorsally, slightly flattened dorsoventrally, widest across mesothoracic wingpads; light to dark brown, heavily marked with cream spots.

Vertex ca. 2× broader than long, lateral margins carinate, triangular, anteromedially meeting carinae of frons; posterior margin obscured by anterior margin of pronotum. Frons 2× longer than wide, dorsal margin convex, lateral margins weakly convex and carinate (outer carinae) roughly paralleled by inner carina on each side, with median longitudinal carina; juncture with clypeus slightly concave; ca. 32 pits, most corresponding with pale spots, between each inner and outer carina. Clypeus

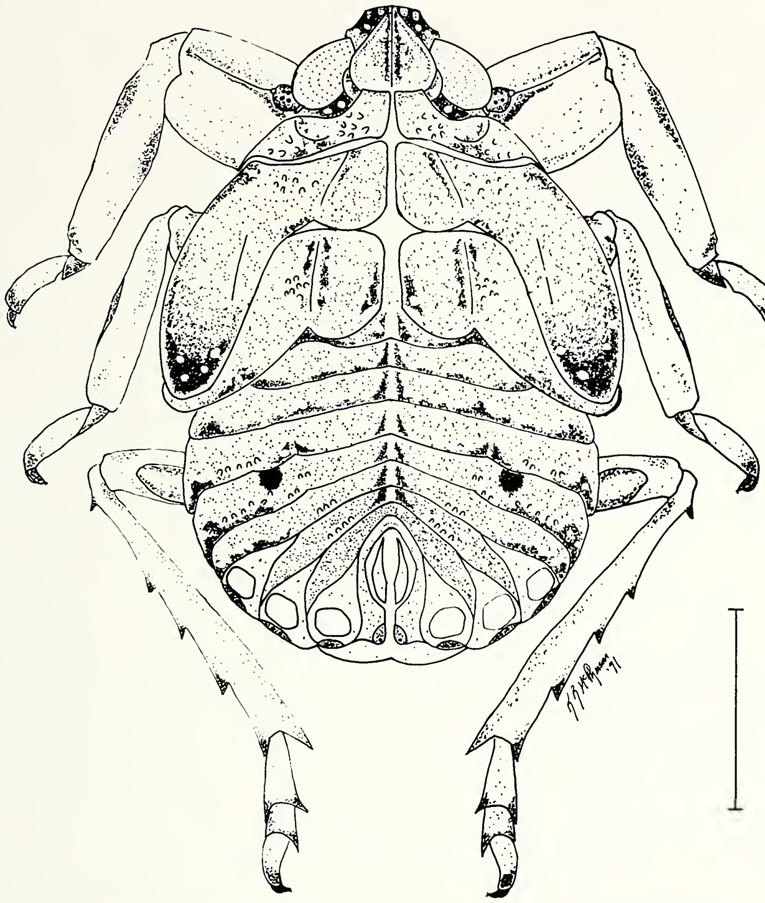

Fig. 2. *Phylloscelis pallescens* fifth instar, dorsal view. Bar = 1 mm.

consisting of a conical basal anteclypeus and a conical distal postclypeus, both slightly flattened laterally, medially carinate, lateral margins carinate; anteclypeus medium brown with 4 regular rows of cream spots, each row containing 4–5 spots; postclypeus dark brown with cream spots. Beak 3-segmented, extending to metacoxae; segment 1 obscured by postclypeus, segment 2 ca. 1.5× longer than segment 3, segments 1 and 2 cream colored, segment 3 cream colored with distal ⅓ sharply changing to dark brown. Eyes reddish with pale stripes. Antennae 3-segmented, scape short and ringlike; pedicel subcylindrical, ca. ¼× size of eye; pedicel with 19–21 pits, 3 rows of 4 pits each visible from ventral view and 4 rows of 2 pits each visible in dorsal view, occasionally a pit present outside of the rows; flagellum whiplike distally, bulbous base ca. ¼× length of pedicel.

Thoracic nota divided by longitudinal mid-dorsal line into 3 pairs of plates. Pronotal anterior margin straight, carinate in middle, curving posterolaterally, posterior margin sinuate; each plate with 2 irregular rows of pits usually corre-

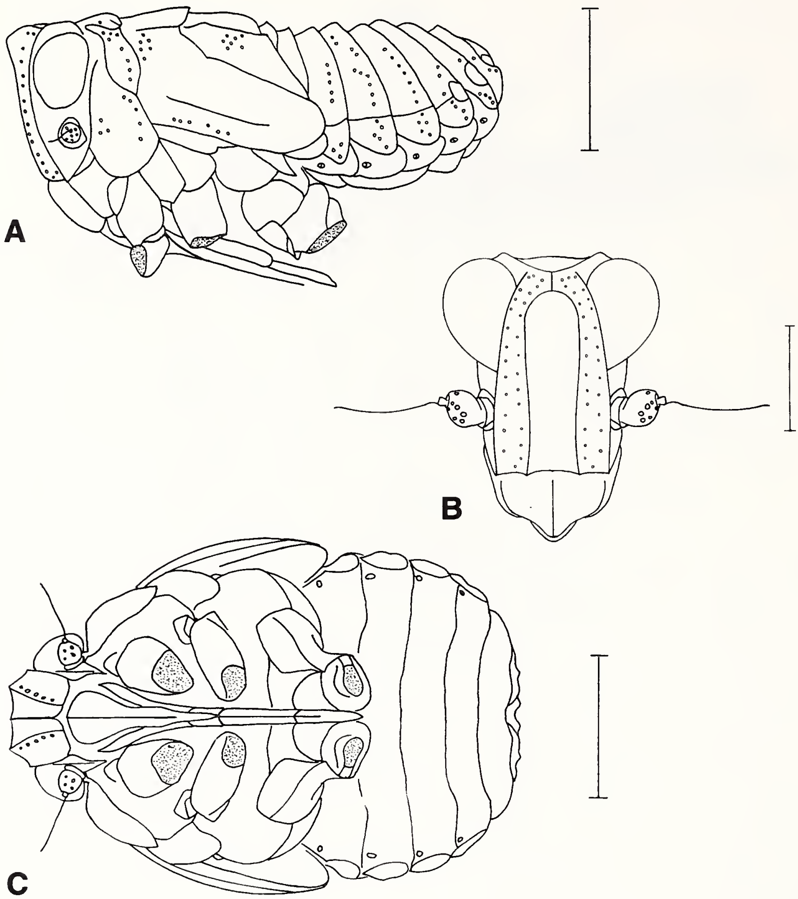

Fig. 3. *Phylloscelis pallescens* fifth instar. A. Left lateral view. B. Frontal view. C. Ventral view. Bars = 1 mm.

sponding with cream spots, totaling ca. 23 pits (lateralmost pits not visible in dorsal view). Mesonotal median length 2× that of pronotum; each plate with carina originating on anterior margin in median ¼ and extending posterolaterally to posterior margin; cluster of 4 pits just lateral to carina and 3–4 pits on wing pad; wingpad lobate, extending nearly to apex of metanotal wingpad. Metanotal median length ca. 0.8× that of mesonotum; each plate with longitudinal carina originating on anterior margin as an extension of mesonotum carina; cluster of 8 pits just lateral to carina; wingpad broadly lobate; extending laterally to anterior margin of tergite 3. Pro- and mesocoxae short, triangular in cross section, posterolaterally directed; procoxae with elevated, longitudinal carina on the lateral aspect. Mesocoxae carinate, less prominent than procoxae. Metacoxae fused to sternum. Profemora greatly foliose laterally, subtriangular in cross-section. Meso- and metafemora only slightly foliose, less strongly carinate than profemora. Pro-

and mesotibia subtriangular in cross-section, each corner with a lateral carina; metatibiae slightly flattened and subtriangular in cross-section, longitudinal row of 4 lateral spines on shaft, and a transverse apical row of 8–9 spines (generally 8) on plantar surface. Pro- and mesotarsi each with 2 tarsomeres; tarsomere 1 wedge-shaped; tarsomere 2 subcylindrical and curved. Metatarsi each with 3 subcylindrical tarsomeres; tarsomere 1 with transverse apical row of 10–12 spines (generally 11) apically on plantar surface; tarsomere 2 with apical row of 7–8 spines (generally 8) on plantar surface; tarsomere 3 similar to terminal tarsomere of other legs. All legs with terminal pair of dark brown curved claws and a clear, membranous, lobate, median pulvillus.

Abdomen 9 segmented, subcylindrical in cross-section, slightly flattened dorsoventrally, widest across tergite 4; tergites 7–9 telescoped anteriorly, tergites 6–8 each with oval dark cream caudal waxpads. Tergite 9 elongate vertically, surrounding anus, with 1 pit on each side; posteriormost margin with brown bulbous protrusion on either side of midline. Tergites 2–7 each with a weak median longitudinal carina. Each tergite with the following number of pits on either side of midline (lateralmost pits not visible in dorsal view due to curving of tergites onto ventral aspect): tergite 3 with 1–2 pits, tergites 4–5 each with 12 pits, tergite 6 with 10 pits, tergite 7 with 8 pits, tergite 8 with 6 pits, and tergite 9 with 1 pit. Tergite 5 with a pair of dark brown spots on either side, ca. ½× distance from midline to lateral edge.

Fourth Instar (Figs. 4A, 5). Length 2.47 ± 0.03; thoracic length 1.16 ± 0.02; width 1.50 ± 0.02. N = 10.

Frons with ca. 28 pits between each inner and outer carina. Anteclypeus with 3 regular rows of cream spots, each row containing 3 spots. Antennal pedicel with 12–14 pits, 2 rows of 3 pits visible in ventral view, and scatter of pits with no discernible pattern visible in dorsal view.

Pronotal plates each with ca. 19–20 pits in 2 irregular rows, ventrolateral surface with 7–8 pits in an irregular pattern. Mesonotal plates each with 4 pits just lateral to carina and 5 pits on wingpad. Wingpad broadly lobate, covering ⅓ of metanotal wingpad laterally. Metanotum with cluster of 5 pits just lateral to carina, wingpad with 2 pits in lateral ⅓. Profemora and protibiae less foliose. Metatarsomere 1 with apical transverse row of 9–10 spines (generally 9) on plantar surface. Metatarsomere 2 with transverse apical row of 5 spines on plantar surface.

Abdominal tergites each with the following number of pits on either side of midline (lateralmost pits not visible in dorsal view): tergite 4 with 10 pits, 5 with 11 pits, 6 with 8 pits, 7 with 7 pits, and 8 with 3 pits, tergite 9 with 1 pit.

Third Instar (Figs. 4B, 5). Length 2.38 ± 0.03; thoracic length 1.01 ± 0.02; width 1.27 ± 0.02. N = 10.

Vertex ca. 1.5× broader than long. Frons 3× longer than wide. Anteclypeus with few to no distinguishable cream spots. Antennal pedicel with 7–8 pits.

Pronotal plates each with ca. 17–18 pits in 2 irregular rows, ventrolateral surface with ca. 8 pits. Mesonotal wing pad with 3 pits; wingpad lobate, covering ¼ of metanotal wingpad laterally. Metanotum on each side with cluster of 4 pits just lateral to carina; wingpad with 1 pit. Profemora and protibiae less foliose. Metatibia with an apical transverse row of 7 spines on plantar surface. Metatarsi with 2 tarsomeres; tarsomere 2 cylindrical with an apical transverse row of 8 spines on plantar surface; tarsomere 1 with transverse apical row of 2 to 3 spines (generally 3).

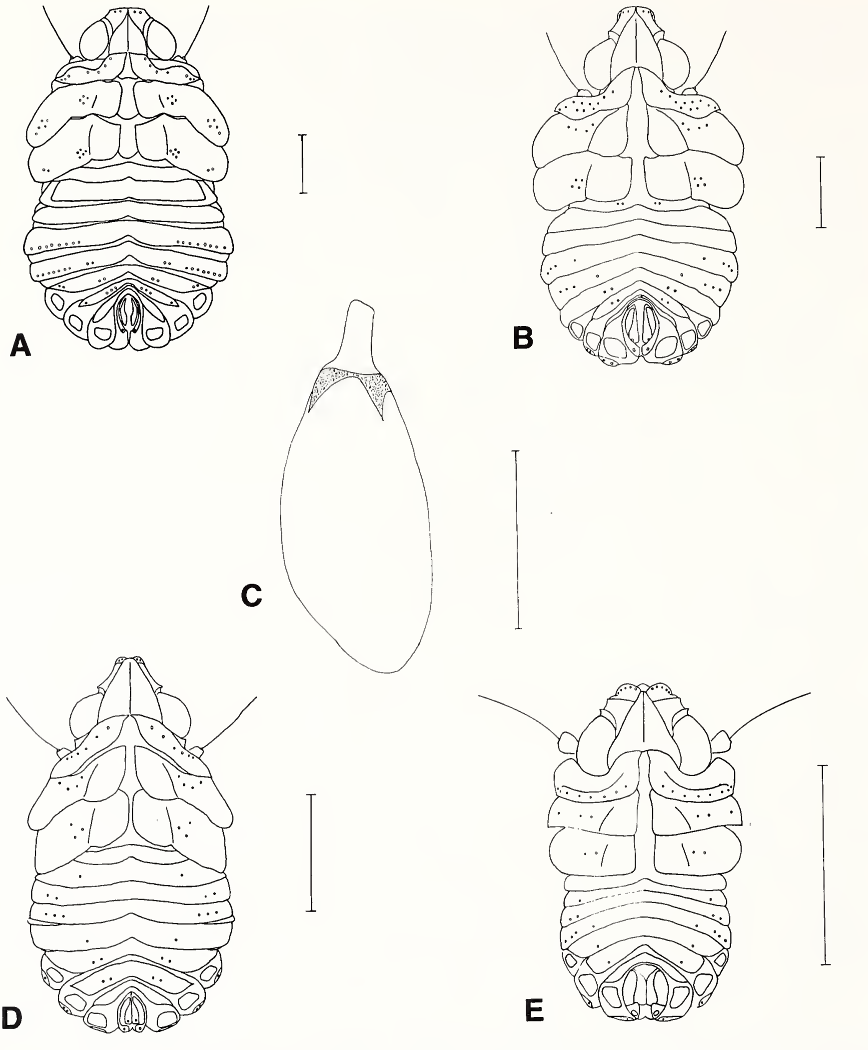

Fig. 4. *Phylloscelis pallescens* immature stages. A. Fourth instar. B. Third instar. C. Egg. D. Second Instar. E. First instar. Bars = 1 mm.

Abdominal tergites each with the following number of pits on either side of midline (lateralmost pits not visible in dorsal view): tergite 4 with 7 pits, tergite 5 with 9 pits, tergite 6 with 6 pits, tergite 7 with 5 pits, tergite 8 with 3 pits, and tergite 9 with 1 pit.

Second Instar (Figs. 4D, 5). Length 1.61 ± 0.02; thoracic length 0.81 ± 0.01; width 0.88 ± 0.02. N = 10.

Vertex subequal in length and width. Anteclypeus with no cream spots, medial carina with a thin cream colored strip. Antennal pedicel with 5 pits.

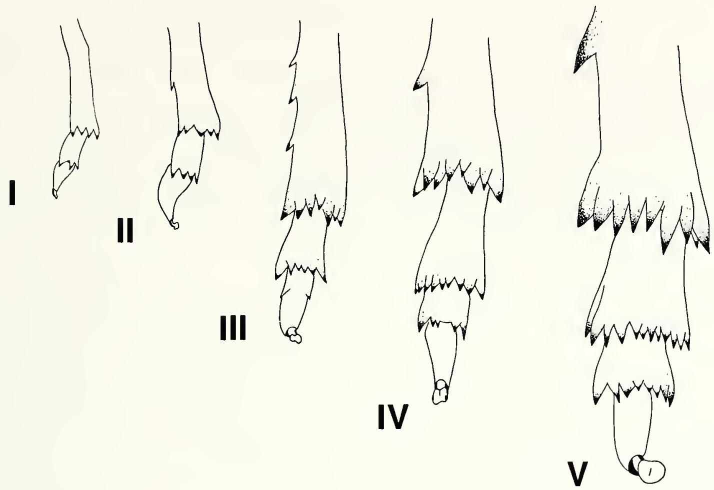

Fig. 5. *Phylloscelis pallescens* apices of metathoracic legs, plantar surface. I–V = nymphal instars.

Pronotal plates each with ca. 12 pits in 1 irregular row, ventrolateral surface with 5 pits. Mesonotum with cluster of 3 pits on each side just lateral to carina, each wingpad with 3 pits. Metanotum with cluster of 3 pits on each side just lateral to carina. Profemora less foliose; protibiae not foliose. Metatibia with an apical transverse row of 5 spines on plantar surface. Metatarsomere 2 with an apical transverse row of 6 spines on plantar surface; tarsomere 1 similar to tarsomeres of other legs.

Abdominal tergites each with the following number of pits on either side of midline (lateralmost pits not visible in dorsal view): tergite 4 with 6 pits, tergite 5 with 6 pits, tergite 6 with 5 pits, tergite 7 with 4 pits, tergite 8 with 2 pits, and tergite 9 with 1 pit.

First Instar (Figs. 4E, 5). Length 0.86 ± 0.01; thoracic length 0.48 ± 0.01; width 0.49 ± 0.02. N = 6.

Antennal pedicel with 3 pits.

Pronotal plates each with ca. 10 pits, ventrolateral surface with 4 pits. Mesonotum with 2 pits on each side just lateral to carinal; each wingpad with 2 pits, no overlap of metanotal wingpad. Metanotum with 2 pits on each side just lateral to carina. Metatibia with an apical transverse row of 4 spines. Metatarsomere 1 with an apical transverse row of 4 spines.

Abdominal tergites each with the following number of pits on either side of midline (lateralmost pits not visible in dorsal view): tergite 4 with 4 pits, tergite 5 with 5 pits, tergite 6 with 3 pits, tergite 7 with 3 pits, tergite 8 with 1 pit, and tergite 9 with 1 pit.

Egg (Fig. 4C). Length 1.04 ± 0.01; width 0.42 ± 0.01. N = 8.

Eggs elongate, oval: cream white: chorion translucent, cephalic end with short cylindrical process.

KEY TO *P. PALLESCENS* NYMPHAL INSTARS

1. Anteclypeus with 4 regular rows of cream spots; metatarsi with 3 tarsomeres; mesonotal wingpad covering ⅓ or more of metanotal wingpad 2
– Anteclypeus lacking rows of cream spots; metatarsi with 2 tarsomeres; mesonotal wingpad covering ¼ or less of metanotal wingpad 3
2. More than 28 pits between each inner and outer carina of frons; anteclypeus with 4 regular rows of cream spots, each row with 4 to 5 spots; tarsomere 1 with 10–12 spines; tarsomere 2 with 7–8 spines; mesonotal wingpad extends to near apex of metanotal wingpad (Figs. 2, 3, 5) . . . . 5th Instar
– Fewer than 28 pits between each inner and outer carina of frons; anteclypeus with 4 regular rows of cream spots, each row with 3 spots; tarsomere 1 with 9–10 spines; tarsomere 2 with 5 spines; mesonotal wingpad covering ⅓ metanotal wingpad (Figs. 4A, 5) . . . . 4th Instar
3. Pronotal plates each with ca. 17–18 pits in 2 irregular rows; vertex broader than long in dorsal view; metatibia with apical row of 7 spines on plantar surface; tarsomere 1 with 8 spines; tarsomere 2 with 2–3 spines (Figs. 4B, 5) . . . . 3rd Instar
– Pronotal plates each with 12 or fewer pits in 1 irregular row; vertex subequal in length and width in dorsal view; metatibia with apical row of 5 or fewer spines on plantar surface; tarsomere 1 with 6 or fewer spines; tarsomere 2 without spines 4
4. Pronotal plates each with 12 pits; metatibia with apical row of 5 spines on plantar surface; tarsomere 1 with 6 spines (Figs. 4D, 5) . . . . 2nd Instar
– Pronotal plates each with 10 pits in 1 irregular row; metatibia with apical row of 3–4 spines on plantar surface; tarsomere 1 with 4 spines (Figs. 4E, 5) . . . . 1st Instar

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THE LARVA OF *NEOCORDULIA BATESI LONGIPOLLEX* CALVERT, 1909 (ODONATA: CORDULIIDAE)

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Abstract.—The Neotropical genus *Neocordulia* is a rare, small, and very poorly known group of dragonflies, including eight species known to date. Only the larva of *N. biancoi* has been described. The larva of *N. b. longipollex* is characterized by: body densely covered with scale-like setae; frons strongly produced anteriorly in a shelf; antennae short with the third joint the longest; prementum abruptly narrowed basally; premental setae 5+4, palpal setae 5. Meso- and metasternum strongly hollowed out for reception of labium. Abdomen without lateral spines or dorsal protuberances; segment 10 reduced. Differences in frontal projection, proportion of antennomeres, number of premental and palpal setae, and presence/absence of abdominal spines, permit the separation of the larva of *N. b. longipollex* from that of *N. biancoi.*

The Neotropical genus *Neocordulia* includes eight species known to date (May, 1991), five of which are restricted to South America. All three Central American species occur in Costa Rica: *Neocordulia batesi longipollex* Calvert, 1909; *N. campana* May and Knopf, 1988 and *N. griphus* May, 1991. The northernmost record of *Neocordulia* is Oaxaca, Mexico (González, 1985), represented by *N. b. longipollex.*

This rather rare genus is very poorly known in distribution, immature stages, behavior, phylogenetic relationships, and other aspects. At present, only one larva has been described: *N. biancoi* from Venezuela (De Marmels, 1990). Here we describe the larva of *N. b. longipollex* with material from Costa Rica. This subspecies ranges from México to Panamá, being replaced in South America by *N. b. batesi* (May, 1991).

MATERIAL AND METHODS

The specimens were not reared but the exuviae were collected at a stream with a relatively high population of teneral adults of *N. b. longipollex.* Moreover, the other two species inhabiting Costa Rica have never been collected at this locality. Exuviae were preserved in 80% ethanol and are deposited at the Aquatic Insects Collection of Instituto de Ecología, Xalapa, Veracruz, México (IEXA), and in the personal collection of junior author. Illustrations were made under stereoscopic microscope using a camera lucida; all drawings by senior author.

Neocordulia batesi longipollex Calvert
(Figs. 1–11)

Material examined: 13 exuviae (ultimate instar) 9 ♂, 4 ♀. COSTA RICA: Prov. Limón; Guápiles, Río Danta, 200 m asl, 22-IV-1993, A. Ramírez, R. Novelo leg.

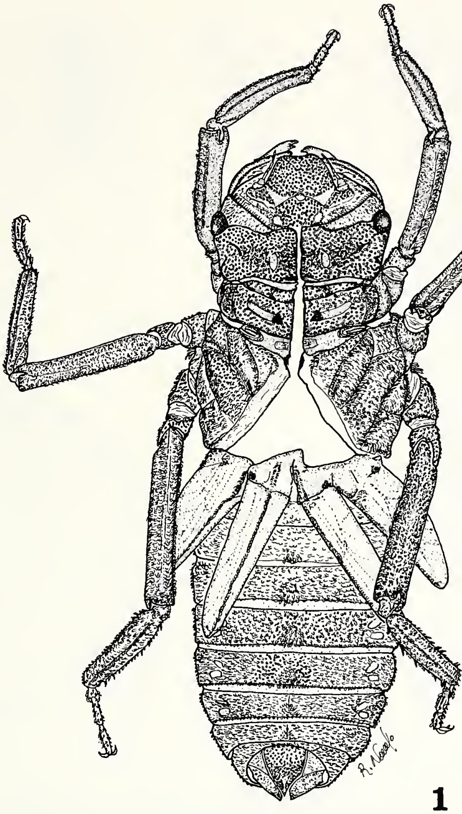
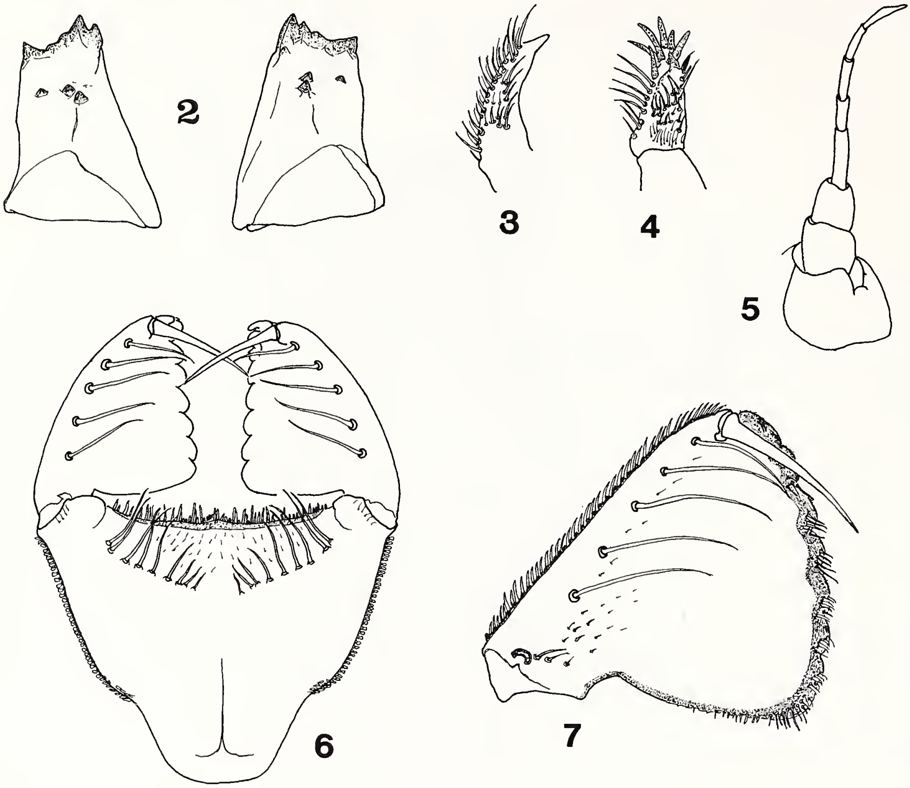


Fig. 1. *Neocordulia batesi longipollex,* exuvia of ultimate instar larva (♂), dorsal view.

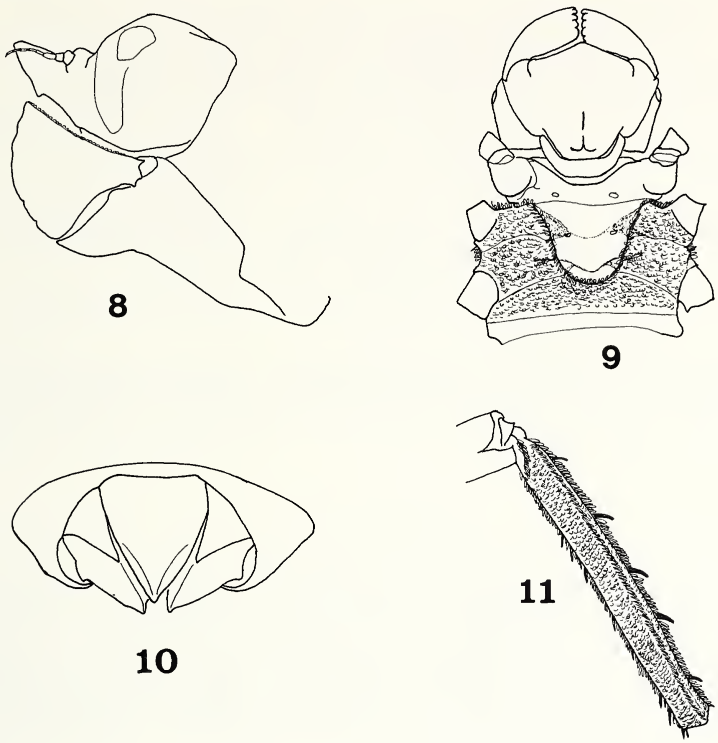
Description: Exuviae yellow-brown to brown; body robust, covered with scale-like setae; head large, as wide as remainder of body; legs rather short (e.g.: metafemora and metatibia together extending slightly beyond of the apex of abdomen); abdomen short, rounded at apical end.

Head wider than long; compound eyes small; frons strongly produced anteriorly in a notable shelf (Figs. 1, 8) with anterior edge slightly concave medially; hind angles of cephalic lobes produced in a straight, slightly raised border, covered with scale-like setae; occipital border sinuate. Antennae very short, 7-jointed, the third antennomere the longest and the fourth the shortest one; proportion of antennomeres: 0.92, 0.78, 1.0, 0.50, 0.71, 0.64, 0.85; scape and pedicel much wider than flagellomeres (Fig. 5). Anterior margin of labrum deeply notched at middle; labrum surface densely covered with long setae. Mandibles biramous, although the internal branch is reduced to three low, blunt-tipped, conical teeth (Fig. 2). Galeolaciniae with seven robust teeth, the dorsal three smaller than ventral four (Fig. 4); maxillary palpi covered with numerous, strong, long setae (Fig. 3). Prementum-postmentum articulation reaching the level of metacoxae;



Figs. 2–7. Details of morphology of *N. b. longipollex.* 2) Mandibles: a, left; b, right. 3) Apex of maxillary palp. 4) Galeolacinia. 5) Antenna. 6) Prementum, dorsal view. 7) Left labial palp.

prementum strongly narrowed at basal third, lateral margins with scale-like setae; ligula slightly serrated at its apical border, slightly produced medially, beset with robust spine-like setae; premental setae 5+4 to each side of midline (Fig. 6). Palpal setae 5 (Fig. 7). *Thorax:* Pronotum with lateral margins straight, directed upwards, its anterior and posterior angles rounded; posterior margin sinuate. Legs slender, densely cover with scale-like setae; metatibiae with 5–6 spur-like setae (Fig. 11). Wing sheaths reaching the abdominal segment 6, parallel-sided (in Fig. 1 they appear as divergent but it is due to distorsion of the exuvia). Meso- and metasternum strongly hollowed out to provide space for the labium, this impression fringed with scale-like setae (Fig. 9), which probably act as proprioceptors. *Abdomen* without dorsal protuberances or lateral spines; without a definite color pattern at least in exuviae; abdominal segment 10 reduced as compared to the preceding ones (Figs. 1, 10); epiproct, paraprocts and cerci pyramidal, acutely pointed, proportions: 1.0, 0.74 and 0.52 respectively (Fig. 10). Female gonapophyses vestigial, reduced to small triangular plates.



Figs. 8–11. Details of morphology of *N. b. longipollex.* 8) Left lateral view of head showing frontal projection. 9) Thorax, ventral view, showing cavity of meso- and metasternum. 10) Abdominal segment 10 and caudal appendages. 11) Left metatibia, external view.

Measurements (in mm)—Total length 19.5–21.0; abdomen 11–11.5; head: width 5.0, length 3.7–4.0; metafemur 5.0–5.5; paraprocts 1.4, epiproct 1.9.
Habitat—Exuviae were found at a rocky stream where the water flow is rapid; they were attached to vertical walls of big rocks situated close to the center of the stream course; teneral adults were captured hanging under leaves to 2–3 m above the water level.

DISCUSSION

May (1991) proposed the division of *Neocordulia* into two subgenera based exclusively in adult characteristics: *N.* (*Neocordulia*) and *N.* (*Mesocordulia*). The only larva hitherto known belongs to the former: *N.* (*Neocordulia*) *biancoi.* The larva here described belongs to the second one: *N.* (*Mesocordulia*) *batesi longipollex.* Differences found between larvae of these two species, which are summarized in Table 1, support May's proposition.

Table 1. Comparative table of the larval features of *Neocordulia.*

Features	*N.* (*Neocordulia*) *biancoi*	*N.* (*Mesocordulia*) *batesi longipollex*
Frons	Moderately produced in a sharp, straight, transverse ridge	Strongly produced in a notable shelf, slightly concave at middle
Raptorial setae	Premental 7 + 4 Palpal 7	Premental 5 + 4 Palpal 5
Antennae	Sixth antennomere the longest	Third antennomere the longest
Pronotum	Hind margin ending on each side in a conical tubercle	Hind margin ending rounded on each side
Femora	With spur-like setae on dorsal carinae	Without such structures
Abdomen	Lateral spines on segments 8–9	No lateral spines at all
Caudal appendages	Paraprocts notably longer than epiproct	Paraprocts shorter than epiproct

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OBSERVATIONS IN TAIWAN ON THE IDENTITY OF THE CUBAN LAUREL THRIPS (THYSANOPTERA, PHLAEOTHRIPIDAE)

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Abstract.—The name *Gynaikothrips ficorum* is retained for the leaf-galling thrips species on decorative *Ficus* trees that has been distributed worldwide by the horticultural trade. Observations on this species and the closely similar species *Gynaikothrips uzeli* suggest that they are largely distinct and host-limited, although co-existing in Southeast Asia even within a single gall.

The Cuban Laurel Thrips, the common name in North American entomology for *Gynaikothrips ficorum* (Marchal), was first used in print by the Florida entomologist J. R. Watson (1918). Despite this name, neither the thrips nor its host plant, *Ficus microcarpa,* is native to the Western Hemisphere, both the tree and the insect having been introduced from Southeast Asia. The tree is widely cultivated throughout the tropics and subtropics. It provides shade in thousands of market places throughout much of Latin America, and is planted in various parts of southern Europe, several coastal resorts of Australia, and even urban shopping malls in north America. Wherever the tree is grown, it rarely lacks the simple leaf-fold or leaf-roll galls induced by the thrips (Denmark, 1967), and as with many such migrants, considerable identification and nomenclatural problems occur.

Phloeothrips ficorum Marchal (1908) was described from Algeria, on material collected from *Ficus microcarpa* (as *nitida*). At various times since then it has been considered to be the same species as *Mesothrips uzeli* Zimmermann (1900) from Java, the type-species of the genus *Gynaikothrips.* In contrast, Priesner (1939) and del Cañizo (1945) distinguished the adults as two species on the basis of the length of the pronotal posteroangular pair of setae, and most workers have accepted this distinction. Jacot-Guillarmod and Brothers (1986) included five specific names in synonymy under *G. ficorum,* and a further two names under *G. uzeli.*

Material available in various museum collections suggests that *G. uzeli* occurs only in Asia, and that it is restricted to *Ficus benjamina.* Despite this, routine identification of *G. ficorum,* a widespread pest of some importance in the horticultural trade on the many cultivars of *Ficus microcarpa* trees, is sometimes not easy because of the morphological variation that is commonly observed. Mound and Marullo (1996), in their overview of the Thysanoptera of Latin America, pointed out that further studies in Southeast Asia were needed to understand the patterns of variation found in the thrips associated with leaf galls on the common *Ficus* trees, and the observations reported here are a first step in that direction.

The nomenclature of the host plants of these *Gynaikothrips* species is also confused in the entomological literature. *G. ficorum* appears to be specific to *Ficus microcarpa,* but this is also commonly referred to by various synonymic names including *F. nitida* and *F. retusa.* Unfortunately, *Ficus benjamina* is also sometimes confused with *microcarpa,* although *benjamina* has rather more glossy and drooping leaves and, moreover, is fertilised by different cynipoid wasps (teste Dr. William Ramirez).

A further problem is that in Southeast Asia the leaf galis of *Gynaikothrips ficorum* and *G. uzeli* often contain individuals or colonies of *Mesothrips jordani* and *M. pyctes,* and members of this genus are commonly considered to be gall-formers (Ananthakrishnan and Raman, 1989). However, judging from the published records, each of the described species of *Mesothrips* has usually been collected together with some other gall-inducing thrips. If *Mesothrips* species really are gall-inducers, then it is curious that they have not accompanied the gall-inducing *Gynaikothrips* around the world on *Ficus microcarpa.*

RECOGNITION OF *GYNAIKOTHRIPS FICORUM* AND *G. UZELI*

Priesner (1939), in an identification key to the members of *Gynaikothrips,* distinguished these two species on the basis that *G. uzeli* has the pronotal posteroangular pair of setae almost as long as the epimeral pair of setae, whereas *G. ficorum* has the posteroangular setae very short. The same character was used by del Cañizo (1945). Our observations on females from many parts of the world indicate that in *G. ficorum* the pronotal posteroangular setae are never more than 0.5 times as long as the epimerals, and usually no longer than the discal setae. In contrast, in Asian material identified as *G. uzeli* the posteroangular setae are usually at least 0.7 times as long as the epimeral setae (rarely less than 0.5), and always longer than the discal setae. These differences are far less reliable in males, possibly because the males are smaller in body size than females and setal lengths are correlated in part with body size. Many males can thus be allocated to species only by their association with females.

Dr Richard zur Strassen (pers. comm.) has pointed out that on abdominal tergites II–IV the pair of major marginal setae close to the wing-retaining setae are usually brown in *G. ficorum,* whereas these setae are pale in specimens from south east Asia that are identified as *G. uzeli.* Although the brown colour of these setae is relatively constant in samples from many other parts of the world, in Taiwan the major lateral setae on tergites II–IV vary both within and between samples of *G. ficorum* from *F. microcarpa.* No consistent pattern of variation was apparent within or between recently collected samples, and the colour ranged from brown to colourless.

In Taiwan, samples of *G. uzeli* with the pronotal posteroangular setae elongate that were collected recently from *Ficus benjamina* have the forewings much more deeply shaded than specimens of *G. ficorum* collected from other parts of the world. These specimens have the forewings considerably darker distally than in the basal third, and the dark area has a strongly marked granular appearance; in *G. ficorum* the forewing is uniformly pale or very weakly shaded around the margins. In some Taiwan populations of *G. uzeli* this wing shading was particularly evident and stable,

although one female was observed with the basal area of the fore wings darker than the distal area (the hind wings were normal).

GYNAIKOTHRIPS ON *FICUS MICROCARPA* IN TAIWAN

Ficus microcarpa is cultivated widely in Taiwan. For example, a yellow leaved form *aurea* is used as a hedge along the central reservation of many major roads. Other cultivars have bicoloured leaves or soft, drooping leaves; many are the subject of elaborate topiary, and bonsai forms are common. All of these cultivars are usually attacked by typical *G. ficorum*. The horticultural trade in Taiwan does not seem to regard the thrips as a serious pest, indeed the reddish folded or rolled leaves might be considered an added attraction. Major plant nurseries in Taiwan are thus a constant source of the thrips, certainly for the local market and presumably also for export markets, and numerous samples were collected recently.

The lengths of the pronotal setae of *G. ficorum* in Taiwan are unusually variable for a member of the Phlaeothripidae. Of the five pairs of major pronotal setae normally found in species of this family, the anteromarginals in this species are never longer than the pronotal discal setae. The anteroangular setae are sometimes longer and stouter than the discal setae, but only in about 10% of the available specimens. The midlateral pair is more commonly enlarged (although difficult to observe), but in no more than than 30% of available specimens. The epimeral setae are always elongate, but the length of the posteroangular pair varies from no longer than the discal setae to almost 0.5 times the length of the epimerals. Moreover, bilateral asymmetry in the development and lengths of the pronotal setae is common.

The setae on the head of *G. ficorum* are also variable. The major pair of postocular setae is usually about 50 microns (although sometimes as much as 70 microns) long, and the pair of setae on the vertex between the postoculars is usually no more than 30 microns long. However, both pairs of setae vary in position as well as length, such that some individuals have no elongate postocular setae, whereas other specimens, even from the same leaf, may have up to four setae that are 50 microns long. These setae are commonly asymmetric in length and position.

The fore tarsal tooth varies in size and curvature, decreasing in size with body size such that in the smallest specimens it is scarcely visible. The forewings are usually clear, but in many specimens they are distinctly shaded around the margins. These variations in body size, setal lengths, forewing colour and fore tarsal tooth size suggests that some of the nominal species described by Priesner (1939), such as *G. edentatus* and *G. insulsus,* may not be valid.

GYNAIKOTHRIPS ON *FICUS BENJAMINA* IN TAIWAN

Ficus benjamina seems to be less commonly cultivated in Taiwan than *F. microcarpa.* A row of young *F. benjamina* trees at the Taiwan Agricultural Research Institute, Taichung, grows within 5 metres of an equal number of *F. microcarpa* form *aurea* bushes. In 1993 these *F. benjamina* trees did not have any thrips galls, whereas rolled-leaf galls containing *G. ficorum* were common on the *aurea* bushes. In March 1995 the same *F. benjamina* trees were observed to have many folded-leaf galls containing *Gynaikothrips* specimens, and therefore a sample of 60 galls was collected and their contents recorded individually. The galls were collected to

Table 1. Thrips in *Ficus benjamina* galls.

Gall stage	*G. uzeli*	*G. ficorum*	*Mesothrips*	*Liothrips*	*Androthrips*
Early (20)	41♀ 6♂	—	5♀ 1♂	2♀	1♀
Young (14)	25♀ 8♂	2♀ 1♂	5♀	1♀	—
Mature (20)	79♀ 47♂	4♀ 17♂	13♀	2♀	1♀

represent three stages of gall development; early stage, with the leaf softly folded but lacking eggs and feeding scars (20 galls); young stage, with the leaf firmly folded, eggs and feeding scars present but leaf tissue still soft (14 galls); mature galls, with extensive feeding scars and the leaf tissue brittle (20 galls).

The mature galls proved difficult to select, because heavy rain in previous weeks had caused considerable thrips mortality; dead thrips and larval exuviae had been swept down into the narrow tip of each gall above the drip-point of the leaf. Also many mature galls contained few thrips but several adults or nymphs of a predatory anthocorid bug. Even several of the second stage galls selected in the field proved to be empty, possibly because the galls had been abandoned or the gall initiator had been eaten. However, thrips species that form simple leaf-roll and leaf-fold galls, like those on *Ficus,* have been observed previously to move in and out of galls during the course of any day; the dynamics of such movements need further study. Since the objective of taking the samples was to determine the thrips species present, mature galls were selected only when containing live thrips. The totals are given in Table 1.

The figures in Table 1 suggest that *G. uzeli* alone was responsible for gall induction on these *F. benjamina* trees. In 14 of the 20 early stage galls *G. uzeli* was found alone, although the more abundant species in the area, *G. ficorum,* apparently entered some older galls. Three of the young stage galls contained a single mature adult *G. ficorum,* eight of the mature galls contained one to three adult *G. ficorum,* and one gall contained 2♀ 7♂ of *G. ficorum* together with 5♀ 7♂ of *G. uzeli.* In this gall, the *G. ficorum* had evidently bred, because some of the males were still teneral.

In none of the galls, including all of the early stage galls, was a *Mesothrips* specimen present alone, although six of these galls contained a single adult *Mesothrips* together with *G. uzeli.* This species is either *Mesothrips jordani* or *M. pyctes,* or these two species may be synonyms. Further studies are needed to establish its identity, but it is notable in having the females variable in body size, with the fore tarsal teeth varying from small and weak to massive. This variation in body form is known to be associated in some thrips species with competitive behaviour, either in defense of a mate (Crespi, 1990) or in defense of a gall (Crespi and Mound, 1996). Since *Mesothrips* were not found alone in any early stage gall, and considering their variation in body structure, this species is probably a gall- invader (kleptoparasite) rather than a gall-inducer.

DISCUSSION AND CONCLUSION

These observations raise as many questions as they provide answers. Can the reverse invasion occur, that is, *G. uzeli* entering *G. ficorum* galls? At the time of these observations the *G. ficorum* leaf-roll galls on the local *aurea* bushes contained

only dead thrips, and as the bushes were not producing young leaves new galls could not be induced. What is the significance of the gall form, whether leaf-fold or leaf-roll? Currently it seems that leaf-folds are more commonly associated with *G. uzeli* on *F. benjamina,* and leaf-rolls with *G. ficorum* on *F. microcarpa,* but there is no clear evidence of a species specific reaction by either the plant or insect. The thrips behaviour also requires further study. To what extent do *Gynaikothrips* individuals remain within, or move between, individual galls? Does the *Mesothrips* species exhibit aggressive behaviour toward the *Gynaikothrips* when invading a gall? Two further unrelated thrips occur commonly in these galls (Table 1). The *Androthrips* species is considered to be predatory (Ananthakrishnan and Raman, 1989), but does the *Liothrips* species lay eggs within the galls, or is it simply sheltering there?—as its behaviour in running away very fast when disturbed might suggest.

Mound and Marullo (1996) suggested the possibility that *G. ficorum* represents an inbred strain distributed artificially by the horticultural trade, and that *G. uzeli* and *G. ficorum* might represent different parts of the natural variation of a single species that is naturally widespread in Southeast Asia. Given that the two forms coexist within galls in Taiwan, the possibility of some inter-breeding cannot be excluded. However, the available samples suggest that even in that country the two are largely distinct. Therefore, at present, it seems useful to retain the name *Gynaikothrips ficorum* (Marchal) for the 'trade form' of pest thrips found so commonly on *Ficus microcarpa* and its cultivars in the worldwide horticultural trade, and to retain the name *G. uzeli* (Zimmermann) for the Southeast Asian form with elongate pronotal posteroangular setae.

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CARDENOLIDES (HEART POISONS) IN THE PAINTED GRASSHOPPER *POECILOCERUS PICTUS* F. (ORTHOPTERA: PYRGOMORPHIDAE) FEEDING ON THE MILKWEED *CALOTROPIS GIGANTEA* L. (ASCLEPIADACEAE)

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Abstract.—The painted grasshopper *Poecilocerus pictus* F. feeds on the poisonous milkweed *Calotropis gigantea.* Cardenolide content in the various tissues of gravid females of this insect has been analysed and significant differences in the levels of cardenolides have been found in different tissues. The metathoracic scent gland, ovary and egg have been found to sequester higher concentrations of cardenolides. The accessory salivary system (reservoir), that is closely associated with the crop and the midgut, has been found to excrete the cardenolides, as evidenced from the analyses of the spittle emitted as droplets by satiated life stages.

At least fifteen species from eight orders of insects have been found to feed and reproduce on the plants of milkweed family Asclepiadaceae and Apocyanaceae (Von Euw et al., 1967, and Rothschild, 1972). They include several species of Lygaeidae (Duffey and Scudder, 1972; Isman, 1977; Moore and Scudder, 1986 and Dingle, 1991); Lepidoptera (Duffey, 1970, Brower et al., 1984 and Holzinger et al., 1992); Coleoptera (Rothschild, 1972; Hilker et al., 1993 and Eggenberger and Rowell-Rabier, 1993); aphids (Isman et al., 1977); scale insects (Rothschild et al., 1973); Cerambycidae (Duffey and Scudder, 1972); moths (Wink et al., 1990) and Orthoptera (Von Euw et al., 1967). It has been well established that these insects at some stage in their life cycle are able to sequester and store the heart poisons called cardenoides (cardiac glycosides) derived from their host plants and such insects are often brightly coloured (aposematic). It has been suggested that such compounds serve as chemical defense against vertebrate predators (Brower and Brower, 1964; Parsons, 1965; Von Euw et al., 1967, 1971; Reichesten et al., 1968, and Rothschild and Kellet, 1972).

In India, ten species of insects have been recorded on the milkweed *Calotropis gigantea* (L.), Asclepiadaceae (Pugalenthi and Livingstone, 1993). *Poecilocerus pictus* is a core species that feeds and breeds exclusively on the poisonous weed and utilizes the toxic cardenolides for its aposematic self-defence, (Livingstone and Pugalenthi, 1992). When the *Calotropis* bushes are completely denuded, the insects reach the adult stage and then migrate to adjacent supplementary host plants such as *Millingtonia hortensis* (Bignoniaceae), *Jatropha tanjorensis* (Euphorbiaceae), *Carica papaya* (Caricaceae) and *Moringa pterygosperma* (Moringaceae) which are totally devoid of cardenoides. Insects which are known to feed and breed on *Calotropis gigantea,* when reared on plants devoid of cardenoides, fail to develop and reproduce due to nutritional deficiency (Livingstone and Pugalenthi, 1992). However,

Table 1. *Poecilocerus pictus*: Cardenolides milieu in various tissues (mg/gram/ml. N-6 Mean ± SD). Means followed by the same letters are not significantly different at 5% level by DMRT.

	Fed on *C. gigantea*	Fed on *C. papaya*
Foregut	2.89 ± 0.72 ab	0.37 ± 0.04 a
Midgut	2.52 ± 0.56 ab	1.21 ± 0.15 b
Hindgut	1.44 ± 0.52 a	0.42 ± 0.99 a
Fatbody	1.84 ± 0.35 a	0.92 ± 0.33 b
Muscle	1.64 ± 0.28 a	0.86 ± 0.32 ba
Cuticle	1.39 ± 0.42 a	1.30 ± 0.25 b
Ovary	1.74 ± 0.67 a	1.48 ± 0.58 b
Eggs	1.69 ± 0.64 a	1.42 ± 0.75 b
Scent gland	3.89 ± 0.58 b	2.56 ± 0.46 c
Haemolymph	0.77 ± 0.21 c	0.47 ± 0.09 a
Spittle	1.21 ± 0.88 a	—

the mechanism of sequestration of the heart poisons in the various tissues of these insects, which are hooked to this poisonous weed from time immemorial, is only partially understood (Moore and Scudder, 1985, and Scudder et al., 1986).

MATERIALS AND METHODS

Adult females of *P. pictus,* collected from *C. gigantea* and *C. papaya* (which had fed for more than 45 days after having migrated from *C. gigantea*), were brought to the laboratory and immediately their haemolymph and spittle were collected in clean vials. Then the insects were kept for 30 minutes in a refrigerator at 5°C for immobilization. Such insects were dissected at 0° in insect ringer solution and their tissues such as muscle, fat body, ovary, eggs, foregut, midgut, hindgut, repugnatorial gland and cuticle collected separately.

Extraction and quantification of cardenolides present in the various tissues were carried out by adopting the modified method of Isman et al. (1977) and Eggenberger and Rowell-Rahier (1993). One hundred mg of each tissue from six individuals for each category was extracted with 5 ml of chloroform; methanol (2:1) for six hours and the extraction repeated. Then the two solvents were mixed, dried in hot water bath and the residue dissolved in a mixture of acetonitrile; water (50:50). High Performance Liquid Chromatography (HPLC) was used for cardenolide quantification. Twenty μl of each sample was manually injected and run by reverse phase HPLC (2 pump system; binary LC pump 250, Perkin Elmer) detector; UV diodearry detector 135, wave length: 219 nm, column; Macherey-Nagel cartridge, ca. 18.3 μm 4 × 30 mm, eluent; acetonitrile (Barker) and water (Merck) 50:50, flow rate 1 ml/min. The cardenolides were detected at 2.89 minutes. Ouabain (Sigma, USA) was used as the standard.

RESULTS

Table 1 represents the cardenolide concentration in various tissues of the grasshopper *P. pictus* collected from *C. gigantea* and *C. papaya.* It is clear that the cardenolides are not evenly stored in all the tissues. There is a wide difference in

the cardenolide content of the tissues of *P. pictus* collected from *C. gigantea* and *C. papaya* indicating that the cardenolide content of adult *P. pictus* is correlated with the cardenolide content of their respective diet tissue.

The metathoracic scent gland contains a much higher concentration of cardenolides, when compared with various other tissues in both categories of insects collected from *Calotropis* and papaya. The grasshopper discharges cardenolides from scent glands through the lateral openings of the scent gland, as a detterrent against its predators (Von Euw et al., 1967). It stores more cardenolides in the scent gland after having them transferred from various tissues through the haemolymph, even when it ceases to feed on plants containing cardenolides. It is noteworthy that the scent glands contain 2.56 mg/ml of cardenolides even 45 days after they were weaned from *Calotropis.*

The ovary and eggs of a maturing insect that continued to feed ad libitum, on *Calotropis* register higher concentration of cardenolides when compared with such estimates of insects that were fed on papaya leaves. However, the occurrence of a perceptible concentration of cardenolides in the ovaries and eggs of the second category of insects suggest that certain amount of cardenolides has already been sequestered in these structures and such concentrations do not decline drastically when the insect is weaned to the plants devoid of cardenolides.

In the case of insects collected from milkweeds the foregut registers a higher concentration of cardenolides and the midgut has relatively less quantity when compared with the foregut. This difference leads to the conclusion that the foregut may not absorb more cardenolides from the semidigested food and such cardenolides adhere to its membrane and enhance the cardenolide concentration in the foregut wall. It is also observed that the insects that are collected from papaya also contain residual cardenolides in its alimentary canal. Their midgut persists in revealing relatively higher concentration of cardenolides when compared with the foregut and hindgut. In the insects collected from milkweed the midgut record much high concentration of cardenolices than the hindgut. These results clearly indicate that the midgut is the main region of the alimentary canal through which cardenolides diffuse into the haemolymph.

Fat body, muscle and cuticle also serve as major reservoirs for cardenolides. In the insects collected from papaya, the concentration of cardenolides in the cuticle is not much less when compared with the fat bodies and muscles of the insects fed on *Calotropis.* It is probable that the cuticular cardenolides are not readily released.

Total absence of cardenolides in the spittle of the insects that are fed on papaya could be considered as evidence of selective excretory mechanism of the salivary gland. While cardenolide concentration in the spittle of the insect fed on *C. gigantea* remains high, the haemolymph records very low concentration of cardenolides, suggesting that the salivary gland excretes out the cardenolides from the foregut and midgut to which it is closely associated. Therefore, the excretion in the midgut, mainly in the crop, provides the source of the cardenolides in the saliva. The total absence of cardenolides in the food derived from non cardenolide plants, relieves the salivary gland of the function of excreting cardenolides and therefore the salivary gland of such insects are free from cardenolides. This also provides a very substantive evidence for establishing that these salivary glands function as the major excretory organs, right from the beginning of the digestive process in the foregut itself.

It is commonly observed that well fed, satiated life stages of this insect when allowed to feed continuously on *C. gigantea,* keep dropping spittle in copious amount as a post gorging behaviour. Such spittle when chemically analysed has very high concentration of cardenolides, confirming that salivary glands are among the principal organs excreting such heart poisons in the initial stage of absorption itself, in the foregut and midgut. The occurrence of cardenolides, in lesser concentration, in various other tissues of the insects that continue to feed on papaya could be considered as residual cardenolides, sequestered earlier by these tissues while feeding on *C. gigantea* during larval stages. However, there is no perceptible aposematic colour difference in the two groups of insects, namely the one that continues to feed on *Calotropis* and the other that feeds on papaya at the terminal stage.

DISCUSSION

Sequestration of cardenolides by insects has been documented only in a limited number of species, even though more than fifteen species of insects have been recorded feeding and reproducing on various species of the plants containing cardenolides. Isman et al. (1977) have analysed the cardenolide content of eight species of insects which feed on milkweeds in North America. According to their observations cardenoides concentration varied from species to species. The chrysomelid beetle *Oreina gloriosa* has been found to sequester a variety of cardenolides from their host plants during its various stages of life. The variations in the cardenolide concentrations among the adult individuals and larvae of this beetle is not based on age and size of the insect alone but on the ontogenetic modifications too (Eggenberger and Rowell-Rahier, 1993).

Cardenolide content in several species of the lygaeids, including *Oncopeltus fasciatus, Lygaeus kalmii* and *Spilostethus pandurus* have been thoroughly investigated by Isman et al. (1977), Duffey and Scudder (1972) and Rothschild (1972). These lygaeid bugs that sequester cardenolides are known to store in the fluid of their dorsolateral glands (62-270 μg of cardenolides per insect) in much greater concentrations, nearly 1000 times more than in any other body tissues such as the fat, muscle, metathoracic scent gland, cuticle and haemolymph (Duffey and Scudder, 1972).

Brower and his co-workers have analysed cardenolides content in *Danaus plexippus* both qualitatively and quantitavely. These butterflies sequester cardenolides from milkweeds, while they feed on it during the larval stage. The adults have been found to store cardenolides mostly in the wigns and use them as chemical defence (Brower and Glazier, 1975, and Brower et al., 1975, 1988).

Von Euw et al. (1967) reported earlier that in *Poecilocerus bufonius* the metathoracic scent glands remained as the major reservoir for such toxic cardenolides and the insect had adopted well to this poison and utilized it for its defence, development and reproduction. The LD 50 of Ouabain for this insect was found to be 200 mg/kg while in species of locusts it was found to be only 7 mg/kg.

The present study on the cardenolides concentration in various tissues of *Poecilocerus pictus* clearly illustrates that all the tissues store cardenolides in considerably high concentrations and the insect presents aposematic colouration. Metathoracic scent gland registers highest concentration followed by the fat bodies, muscles and

cuticle. However, haemolymph has relatively lesser concentration of cardenolides. The midgut, among other regions of the alimentary canal has greater concentration of cardenolides, suggesting that it is the main tissue responsible for cardenolides excretion and the salivary gland plays a major role in this function.

The present study therefore unequivocally establishes the fact that the physiology and biochemistry of this painted grasshopper have become highly specialized to utilize the heart poisons for its defence as well as for reproduction and growth. It is also clear that the cardenolides are excreted out through the digestive system and sequestered in the various tissues in varying levels of concentrations for utilization at appropriate stage of reproduction even when the source of nutrition is deprived of cardenolides.

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ARTHROPOD SUCCESSION IN RATS EUTHANIZED WITH CARBON DIOXIDE AND SODIUM PENTOBARBITAL

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Abstract.—Arthropod succession was observed on whole rat carcasses euthanized by CO_2 anoxia and sodium pentobarbital (SP) overdose. Adult Diptera accounted for 84% (417/494) of all arthropods collected of which 76% (319/417) were Calliphoridae. Calliphorid oviposition on SP euthanized rats was protracted throughout the first 7 d of putrefaction compared to CO_2 euthanized rats. Seventy-one percent (353/494) of adult arthropods were associated with SP euthanized rats and SP rats took twice as long to decompose. Arthropod succession and development on rat carcasses was most likely influenced by manner of death.

Key words: forensic entomology.

Cadavers exposed to air undergo a series of decompositional stages and arthropods characteristic of each stage appear in regular succession (Keh, 1985). Forensic entomologists frequently assist homicide investigations in determining the postmortem interval (PMI) or time interval between death and corpse discovery based on the diversity of arthropods present and their developmental stage relative to prevailing environmental conditions.

Manner of death can affect the rate of decomposition and arthropod succession and should be considered when using insects to determine the PMI (Smith, 1976; Catts, 1992). Insects associated with poisoned cadavers arrive and develop at different rates than those associated with mechanical deaths (Utsumi et al., 1958). Poisons can deter early invasion by ovipositing flies, larval feeding and beetle predation and inhibit organisms that enhance decomposition (Glaister and Rentoul, 1966; Lane, 1975; Nuorteva and Nuorteva, 1982; Mann et al., 1990; LeClerq and Vallant, 1992).

Substance abuse from prescription and non-prescription drugs often cause or contribute to the death of an individual. Drugs can be detected in decomposing tissues and in the maggots feeding on such tissues as reviewed by Goff and Lord (1994). The presence of drugs in decomposing tissues also influences the development and pattern of carrion feeding insects and could alter PMI estimates based on the rate of larval and puparial development. Lord (1990) described a homicide case in which a single *Phaenica serricata* (Meigen) larva recovered from the nasal region of a women with a history of cocaine abuse had undergone accelerated growth and was nearly twice the size of other *P. serricata* and *Cynomyopsis cadaverina* (R.-D.) larvae that were present. In laboratory studies, sarcophagid fly colonies developed more rapidly on tissues containing cocaine, heroin (as morphine) and metamphetamine (Goff et

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al., 1989, 1991, 1992). Conversely, the developmental rate of *Parasarcophaga ruficornis* (F.) feeding on tissues containing the antidepressant amitriptyline was not affected however, a prolonged postfeeding period was observed (Goff et al., 1993).

The studies by Goff et al. (1989, 1991, 1992, 1993) used livers and spleens from rabbits receiving known dosages of cocaine, heroin, metamphetamine and amitriptyline as larval media and sarcophagid flies as primary necrophages. The objective of our study was to compare arthropod succession and carcass decomposition in whole rats euthanized by CO_2 anoxia and sodium pentobarbital (SP) overdose under environmental conditions common to central New York. SP, a barbituric acid derivative, is used as a veterinary anesthetic and euthanasia drug. Carbon dioxide euthanasia was selected for comparison to SP overdose because in both cases death results from anoxia (Muir III and Hubbell 1995).

MATERIALS AND METHODS

Five rats were euthanized in a CO_2 chamber and 5 rats were euthanized by intraperitoneal injection of 1.5 cc SP (Nembutal: 64.8 mg SP/cc 10% ethanol in water). Rats weighed 0.25 to 0.40 kg and were culled from a Cornell University nutrition study. Death occurred within seconds for rats receiving SP and within 5 mins for rats euthanized in the CO_2 chamber. One to 4 h after death, rats were placed in 29 $\times$ 36 $\times$ 54 cm wire cages 7 m apart in open pasture behind Schwardt Laboratory, Ithaca, NY. Rats were euthanized and placed in the field on Sept. 13, 1991 (1 CO_2 rat per cage and 1 SP rat per cage) and October 1 and 18, 1991 (2 CO_2 rats per cage and 2 SP rats per cage). Rainfall and afternoon temperature were recorded for 21, 17, and 15 days following placement of the rats in the pasture on Sept. 13, Oct. 1 and 18, respectively.

Diptera and other flying insects, fly larvae and beetles were collected daily as described by Lord and Burger (1983). Although not collected, other insects seen associated with the rat carcasses were recorded in a field notebook. No collections were made after sunset. Time required for fly larval and pupal development were also recorded. Arthropods were identified to family although some calliphorid flies, beetles and yellowjackets were identified to genus and occasionally species. Arthropod diversity and succession were correlated to the stages of decomposition and method of euthanasia. Data were analyzed by *t* test (Systat, 1992).

RESULTS

Sept. 13. Within 1 d postmortem blow fly (Calliphoridae) oviposition was extensive for both CO_2 and SP euthanized rats. For brevity, rats will be referred to as CO_2 and SP rats. Eggs were laid within the nostrils, along the genito-anal areas and along the flanks. The SP rat had eggs in its eyelids and yellowjackets (Vespidae: *Vespula maculifrons* [Buysson]) feeding at the scrotum. The left flank of the CO_2 rat was torn by yellowjackets.

Two d postmortem 0.5–0.7 cm maggots had entered the left flank of the CO_2 rat, eaten through the peritoneum and entered the viscera. The eyes were eaten and nose blood had congealed. Maggots measuring 0.3–0.5 cm on the SP rat were feeding around the face and rectum. A 1 cm larva was noted deep within the perineoscrotal cavity but was not removed. Fly larvae were not detected within the abdomen.

Yellowjackets contributed to carrion decomposition by opening the carcass to other insects.

Three d postmortem 1.1–1.4 cm second and third instars were actively feeding on the intestines, gall bladder, abdominal mesentery, face, mouth and lips of the CO_2 rat. Postfeeding third instars were beginning to leave the corpse. The SP rat was distended and first and second instars were on the nape of the neck, ears, eyes and perineum.

Four d postmortem all viscera of the CO_2 rat were eaten. The bones, hair and papery skin remained. Fly larvae had tunneled into the ground and predators such as: histerid (Histeridae) beetles, rove (Staphylinidae) beetles, sphecid (Sphecidae) wasps and assassin (Reduviidae) bugs dominated. The SP rat was bloated and second instars began feeding on the intestines, liver and kidneys. The largest fly larvae, 1.2–1.5 cm, fed within the perineoscrotal cavity.

Six d postmortem the CO_2 rat was dry. Ants (Formicidae), opilionids (Opiliones) and entomobryiid (Entomobryidae) collembolans scavenged. Much of the SP rat's esophagus and gastrointestinal tract were still intact. The next 5 d exhibited little change in the CO_2 rat whereas larval and adult calliphorids still dominated the SP rat.

The mean afternoon temperature from Sept. 13–Sept. 24 was 24°C (15–36°C). Average rainfall was 0.25 cm. Arthropods associated with the rats described above are listed in Table 1.

Oct. 1. All four CO_2 and SP rats had extensive oviposition near their perianal areas, mouths, necks and flanks within 1 d of death. Adult calliphorid flies were feeding near the rectum and face.

Within 3 d postmortem the CO_2 rats' eyes were liquefied by feeding fly larvae. First instars fed in the nose, flanks and genitourinary system of SP rats. The calliphorid flies *Lucilia* sp. and *Phaenicia* sp. continued to oviposit on the SP rat.

Within 6 d postmortem the CO_2 rats' faces were eaten and their mandibles were free, skin was blackened, fur fell off easily and larvae, having consumed the viscera, started eating the muscles. Staphylinid and histerid beetles also frequented the carcasses. In contrast, the SP rats were still intact, their flesh was pink and fly larvae were concentrated in the genito-anal area and upper thorax. Larval movement appeared somewhat languid in SP rats compared to similar instars in CO_2 rats.

Nine d postmortem the CO_2 rats' brains were eaten, their skins were tight, their thoraces deflated and postfeeding third instars were tunneling in preparation for pupation. The faces and viscera of SP rats were still intact and all fly instars were present. SP rats were mauled by vertebrates, most likely raccoons, 10 d postmortem. Over the next 6 d we observed additional desiccation, melanization and yellowing of the CO_2 rat carcasses. Seventeen d postmortem the CO_2 rats also were eaten by vertebrates.

The mean afternoon temperature from Oct. 1–Oct. 17 was 18°C (9–27°C). Average rainfall was 0.53 cm. Arthropods associated with these four rat carcasses are listed in Table 1. The number of taxa observed or collected from SP rats was significantly greater than the taxa associated with CO_2 rats ($P < 0.05$). The largest number of taxa were observed or collected from Sept. 13 SP rats 4–6 d postmortem ($P < 0.05$).

Oct. 18. The last four rats were never fully decomposed by arthropods. Four d postmortem the 2 SP rats and 1 CO_2 rat were eaten by vertebrates. The four rats

Table 1. Adult arthropod succession to rats euthanized by CO_2 anoxia and sodium pentobarbital (SP) overdose.

Days postmortem	Order[a]	September 13, 1991		October 1, 1991	
		CO_2	SP	CO_2	SP
1	Diptera	Sarcophagidae	Calliphoridae	Calliphoridae	Calliphoridae
		Calliphoridae			
		Ephyridae			
	Hymenoptera	Vespidae	Vespidae		Sphecidae
		Formicidae			
	Coleoptera		Staphylinidae		
	Other	Collembola		Opiliones	Opiliones
					Collembola
2	Diptera	Sarcophagidae	Sarcophagidae	Calliphoridae	Calliphoridae
		Calliphoridae	Calliphoridae	Piophilidae	
	Hymenoptera	Vespidae	Vespidae		
		Formicidae			
	Coleoptera		Staphylinidae		Chrysomelidae
	Other	Opiliones		Opiliones	
		Collembola			
3	Diptera	Sarcophagidae	Sarcophagidae	Calliphoridae	Calliphoridae
		Calliphoridae	Calliphoridae	Sarcophagidae	Sarcophagidae
		Sphaeroceridae	Sepsidae	Muscidae	Piophilidae
		Muscidae	Muscidae		
			Anthomyiidae		
	Hymenoptera	Braconidae	Formicidae		Formicidae
	Coleoptera	Staphylinidae	Staphylinidae		
	Orthoptera		Gryllidae		
	Hemiptera				Reduviidae
	Other		Opiliones	Collembola	Collembola
4	Diptera		Sarcophagidae	Calliphoridae	Calliphoridae
			Calliphoridae		Muscidae
			Muscidae		
			Piophilidae		

Table 1. Continued.

Days postmortem	Order[a]	September 13, 1991		October 1, 1991	
		CO_2	SP	CO_2	SP
			Sphaeroceridae		
			Chloropidae		
	Hymenoptera	Sphecidae	Vespidae		Formicidae
			Formicidae		
	Coleoptera	Staphylinidae	Histeridae	Staphylinidae	Staphylinidae
		Histeridae	Siphilidae	Histeridae	
			Staphylinidae		
	Hemiptera	Reduviidae	Reduviidae		
	Orthoptera		Gryllidae		
	Other		Acari		Collembola
5	Diptera		Sarcophagidae		Calliphoridae
			Calliphoridae		
			Muscidae		
			Phoridae		
			Sciaridae		
			Sphaeroceridae		
	Hymenoptera	Formicidae	Formicidae		Braconidae
	Coleoptera	Staphylinidae	Silphidae	Staphylinidae	
			Histeridae		
			Staphylinidae		
			Chrysomelidae		
	Hemiptera				Reduviidae
	Other	Collembola		Opiliones	Collembola
6	Diptera	Sarcophagidae	Calliphoridae	No collecting	No collecting
			Sepsidae		
			Lonchopteridae		
	Hymenoptera	Formicidae	Braconidae		
	Coleoptera		Staphylinidae		
	Orthoptera		Gryllidae		

Table 1. Continued.

Days postmortem	Order[a]	September 13, 1991		October 1, 1991	
		CO_2	SP	CO_2	SP
	Other	Opiliones	Acar		
7	Diptera	Muscidae	Muscidae	Psychodidae	Sciaridae
		Sphaeroceridae			
	Hymenoptera		Braconidae		
	Coleoptera			Staphylinidae	Staphylinidae
	Orthoptera		Gryllidae		
	Other	Collembola		Collembola	Collembola
					Opiliones
8	Diptera	Sphaeroceridae	Calliphoridae	Calliphoridae	Calliphoridae
			Muscidae	Sphaeroceridae	Sarcophagidae
					Sphaeroceridae
	Coleoptera			Staphylinidae	Staphylinidae
	Hymenoptera				Braconidae
	Orthoptera		Gryllidae		
	Other	Collembola		Collembola	
				days 9–17	
9	Diptera		Muscidae	Sphaeroceridae	
	Coleoptera			Staphylinidae	Staphylinidae
	Hymenoptera		Formicidae		Braconidae
	Orthoptera		Gryllidae		
10	Diptera	Sarcophagidae	Sarcophagidae		
			Calliphoridae		
			Sepsidae		
			Sphaeroceridae		
	Coleoptera		Staphylinidae		
	Hymenoptera	Formicidae	Formicidae		
	Other	Collembola			
11	Diptera	Muscidae	No arthropods		

Table 1. Continued.

Days postmortem	Order[a]	September 13, 1991		October 1, 1991	
		CO_2	SP	CO_2	SP
	Hymenoptera	Formicidae			
	Other	Collembola			
12	Diptera	Sphaeroceridae	Sphaeroceridae		
	Other	Collembola	Araneae		
		Acari			
13	Diptera		Sphaeroceridae		
to	Hymenoptera		Formicidae		
39	Coleoptera		Staphylinidae		
	Other	Collembola	Collembola		

[a] Taxa listed in order of abundance.

Table 2. Adult arthropods collected from rats euthanized by CO_2 anoxia and sodium pentobarbital (SP) overdose.

Taxa	Adults collected	Percent on CO_2 rats	Percent on SP rats	Percent of total
Diptera	417	27.3	72.7	84.4
Coleoptera	27	51.9	48.2	5.5
Hymenoptera	20	30.0	70.0	4.1
Hemiptera	6	16.7	83.3	1.2
Others	24	25.0	75.0	4.9
Total	494	28.5	71.5	100

were visited by calliphorid (*Lucilia* sp., *Phaenicia* sp. and *Phormia* sp.), sarcophagid (*Sarcophaga* sp.) and muscid (Muscidae) flies; braconid (Braconidae) wasps, collembolans, ants and opilionids. The remaining CO_2 rat was observed for 15 d.

Twelve d postmortem distention waned in the remaining CO_2 rat and calliphorid larvae were seen feeding around the vaginal and anal area. Three d later, this rat was still intact, although a putrid smell was evident. The mean afternoon temperature for Oct. 18–Nov. 1 was 15°C (7–23°C). Average rainfall was 0.03 cm and 6 of the 15 d were overcast. The few arthropods associated with the Oct. 18 rats are not included in Table 1.

Fauna. A total of 494 adult arthropods were collected from the seven rats, 28.5% from the four CO_2 rats and 71.5% from the three SP rats (Table 2). Except for the Coleoptera, the majority of adult arthropods were collected from the SP rats compared to CO_2 rats ($P < 0.05$). Diptera accounted for 84% (417/494) of the adult arthropods collected ($P < 0.05$) and 76% (319/417) were Calliphoridae. The predominant calliphorids were *Phaenicia* sp., *Opsodexia* sp., *Lucilia illustris* (Meigen), *Phormia regina* (Meigen) and *Cochliomyia macellaria* (F.). Muscidae accounted for 5.7% (24/417) and Sarcophagidae accounted for 3.4% (14/417) of the Diptera. The remaining families: Sphaeroceridae, Chloropidae, Sepsidae, Lonchopteridae, Phoridae, Ephydridae, Sciaridae and Piophilidae accounted for 14.4% (60/417) of the Diptera.

Seventy-four percent (20/27) of the adult Coleoptera were staphylinids. The genera *Philonthus* sp., *Aleochara* sp., *Omalium* sp. and the predatory species *Creophilus maxilossus* (L.) were predominant. Other beetles associated with the rat carcasses were histerids, incidental leaf beetles (Chrysomelidae) and the carrion beetles *Silpha* sp. and *Nicrophorus* sp., the latter carrying numerous phoretic *Poecilochirus* sp. mites.

DISCUSSION

Both groups of rats attracted similar arthropods. Diptera accounted for 84% (417/494) of collected adults with Coleoptera, Hymenoptera, Hemiptera and others representing between 1–5.5% each. Other arthropods included acarines (Acari), opilionids (Opiliones), gryllids (Gryllidae), collembolans and spiders (Araneae). The number of taxa were fairly constant for CO_2 rats but diverse at the beginning and poor at the end for SP rats. Seventy-one percent (353/494) of adult arthropods were associated with the SP rats.

CO_2 rats decomposed as expected for small rodents (Lane, 1975). Adult insect activity increased from day 2–3, decreased from 4–5 and stabilized after day 5. The SP rats exhibited heightened adult activity from d 2–5 and did not exhibit significant reduction in insect activity until day 7. Increased fly activity on d 2 for both CO_2 and SP rats followed the initial calliphorid oviposition and was comprised of sarcophagids, sphaerocerids, muscids, chloropids, piophilids, sepsids and ephydrids. The CO_2 rats decomposed in half the time as SP rats and were unavailable for additional waves of opportunistic feeders and facultative necrophages. By comparison, when only the bones, hair and skin of the CO_2 rats remained, the SP rats were bloated with feeding second instars. Even 9 d postmortem first instars were detected in SP rats. Calliphorid oviposition on SP rats appeared protracted throughout the 7 d of putrefaction.

Although we did not test for the presence of SP in decomposing rat tissues or in the carrion feeding insects, our results indicate that SP affects fly oviposition and feeding patterns. The presence of SP in the tissues may have inhibited fly larval feeding and development particularly in the abdominal region where the highest concentrations of SP residues would be expected following an intraperitoneal injection. We found Diptera larval feeding concentrated in the genito-anal area, upper thorax and face of the SP rats while most of the gastrointestinal tract and abdominal mesentery was uneaten. Delayed oviposition and larval feeding and development were observed on mercury contaminated fish tissues (Nuorteva and Nuorteva, 1982) and on malathion contaminated human tissues (Gunatilake and Goff, 1989).

Smith (1976) stressed the need for faunal succession studies on whole animal carcasses because similar studies on intact human corpses under field conditions were not ethically or morally possible. Methods used to euthanize animals in experimental studies affect faunal succession as does the kind and size of the animal used (Denno and Cothran, 1975; Hewadikaram and Goff, 1991). For instance, carbon monoxide gas changes the blood hemoglobin which alters body tissues and affects the rate of decomposition and carcasses with artificial wounds would desiccate more rapidly and affect results (Smith, 1976). We compared rats of similar weight euthanized by CO_2 anoxia and SP overdose which also kills by anoxia. Death by cervical fracture occurs through the elimination of the brain blood supply and central nervous system input and is not equivalent to SP euthanasia. Furthermore, cervical fracture is not suitable for animals >100 gm (Muir III and Hubbell, 1995). Although a rise in blood pH would be expected from both CO_2 and SP euthanasia, the latter due to glycolysis after death, CO_2 leaves no residues while SP, which is highly lipid soluble, is concentrated in the fatty tissues. In fact, Beyer et al. (1980) detected phenobarbital, a related barbiturate, in *C. macellaria* larvae feeding on the decomposed remains of a fatal overdose case.

Care must be taken in estimating PMIs from insects feeding on corpses containing poison, drug and toxin residues. Jirón and Cartín (1981) observed insect succession on a dog euthanized with SP during the dry season in Costa Rica. The ecological complexity and fauna associated with the dog's decomposition were reportedly due to the premontane humid climate. Unfortunately, the authors did not consider manner of death in their study of insect succession. Utsumi et al. (1958) identified insects attracted to rats euthanized nine different ways. Insect succession to poisoned rats was fairly constant however, rats euthanized mechanically exhibited plentiful insect

activity at first that later declined. We observed prolonged adult activity and larger numbers of adults on SP rats most likely because SP rats took twice as long to decompose as CO_2 rats.

Although manner of death influences insect succession and development of sarcophagous insects (Smith, 1976). Rats euthanized and placed outside on Sept. 13 decomposed twice as fast as rats euthanized and placed outside on Oct. 1. The mean temperature from Sept. 13–24 was 24°C whereas the mean temperature from Oct. 1–17 was 18°C. Higher temperatures in September accelerated fly larval development and enhanced bacterial putrefaction. Adult Diptera were more numerous in September than October. Two d postmortem a 1 cm larva was found within the perineoscrotal cavity of the Sept. 13 SP carcass. This anomaly may be explained by localized larval mass heat generation or by early hatching. The predominance of calliphorid, sarcophagid, muscid, piophilid, sepsid and phorid larvae in the September rat carcasses increased the rate of decomposition. Although interesting, many of these syanthropic flies are not encountered in typical forensic investigations (Catts and Haskell, 1990). Facultative necrophages, such as Collembola, ants, opilionids, crickets and yellowjackets also were more abundant in September than in October.

Conspicuously missing are the Coleoptera families Trogidae, Dermestidae, Cleridae, and Nitidulidae that are frequently collected from advanced decay and dry stages of carrion (Payne and King, 1970; Smith, 1986). Nocturnal beetles may have been missed because we collected during the day. Other beetles may have been inhibited by the truncated photoperiod of September and October, sporadic rain, the small size of the rat carcasses or an unsuitable biochemical microclimate, all factors to consider in forensic entomology studies.

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NOTES AND COMMENTS

J. New York Entomol. Soc. 103(2):208–214, 1995

SHORT NOTE ON FOSSIL PIPUNCULIDAE (DIPTERA) FROM DOMINICAN AMBER

Pipunculidae are small, usually darkish and inconspicuous flies, closely related to hoverflies (Syrphidae). They can be differentiated by the large compound eyes occupying most of the hemispherical head and by the wing venation. During their larval stage, they are parasitoids of Auchenorrhyncha (Homoptera). World-wide, more than a thousand species are known, distributed over 22 genera (De Meyer, 1994). The fossil record for Pipunculidae is however very limited. Aczél (1948) gave a review of all described specimens. They are all from Baltic amber except one from Miocene Florissant shale. Since then no new descriptions or records were published on fossil pipunculids. Through the kind courtesy of Dr. David Grimaldi (American Museum of Natural History, New York), the author had the opportunity to study new material of Pipunculidae found in Dominican amber. It concerns here two female specimens in two separate inclusions and in fairly good condition. Below follows a description with general discussion on their phylogenetic position.

DESCRIPTION

Eudorylas sp. A
(Fig. 1)

Material. 1 female, in amber from Dominican Republic, specific provenance unknown, purchased from Manuel Perez, AMNH coll Nr DR 11-21. Estimated Oligo-Miocene.

General Habitus (Fig. 1a): The specimen is completely embedded in amber and almost complete (part of left wing and of left mid leg missing). Right hand side is clearly visible; the left and dorsal views are obscured by series of small bubbles and other inclusions. The right wing is folded but most structures and venation visible. Thorax is completely transparent. Most ommatidia, especially anterior ones are obscured. Antennal segments are transparent and hardly discernible.

Description. Body length: approx. 3.5 mm; wing length: approx. 4.2 mm.

Female. Head. Anterior eye facets apparently considerably enlarged (not clear because of obstruction by inclusions). Third antennal segment acuminate; second antennal segment with few short bristly hairs below and above. Front only moderately widened in the middle. Occiput hardly broadened in upper part (Fig. 1c).

Thorax. Propleural fan absent. Mesonotum with dorsocentral hairs apparently completely reduced. Scutellum with row of short fine hairs along apical margin.

Legs simple and typical shape for genus (Fig. 1a). Femora, only mid femur with approx. 7 developed ventral spines at apical third. Front femur apically with few dispersed spiny bristles, poorly developed. Hind femur apparently without ventral

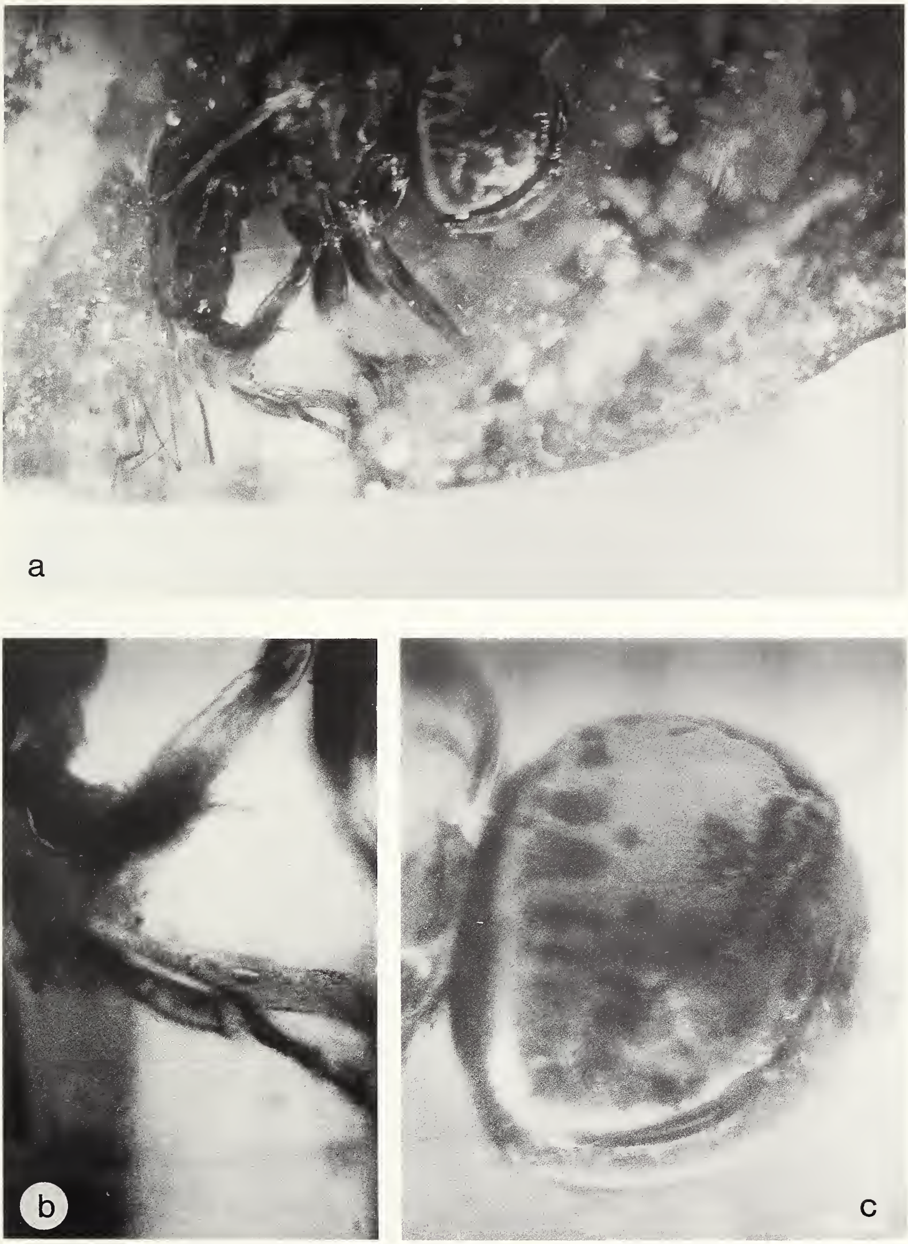

Fig. 1. *Eudorylas* sp. A. a: general habitus, lateral view. b: ovipositor and hind legs, lateral view. c: head, lateral view.

spines. Differences in coloration indicates femora with darkened median ring occupying about half of entire length, more extensively so in front four femora. Tibiae with erected median bristle; front four tibiae with apical spines. Tarsal segments with last tarsal segment darker; pulvilli slightly larger than last tarsal segment, claws more distinctly so.

Wings. Third costal section with pterostigma coloured, coloration not clear but distinct difference in transparency (looked at from certain angle) occupying full length of section. Fourth costal about as long as third section. Cross-vein r-m at base of third section, approx. at basal third of discal cell. Vein M1+2 simple.

Abdomen. Lateral fan with row of long darkish bristly hairs. Terga apparently without pilosity, except few short bristles on tergum 6. Terminalia well developed with base longish and oblong, not bilobed and with median protuberance below; piercer about as long as base, curved upwards (Fig. 1b). In dorsal view apparently with lateral protuberances (not clear, partly obscured).

Discussion. The specimen shows characteristics of Eudorylini: propleural fan absent, and pterostigma coloured. The ovipositor resembles some *Tomosvaryella* species but wing venation (coloured pterostigma, shape and length of third and fourth costal sections) and shape of occiput (not especially broadened in upper part) do not correspond with this representatives of this genus. Within the Eudorylini, the specimen shows characteristics found in the genera *Eudorylas* and *Metadorylas:* second antennal segment with only few short bristles; third antennal segment acuminate, not obtuse. The shape of the ovipositor does not correspond however with the characteristic shape found in contemporary *Metadorylas* sp. but is similar to structure found in some *Eudorylas* like the Nearctic *E. vierecki.* I therefore propose to put the species in the genus *Eudorylas.* Rafael (in press) recently described a number of new *Metadorylas* and *Eudorylas* species from the Dominican Republic. However most of them are based on male material only and no association could be made with the fossil material.

Eudorylas ? sp. B
(Fig. 2)

Material. 1 female, in amber from Dominican Republic. AMNH coll Nr DR 10-1453. Estimated Oligo-Miocene.

General Habitus (Fig. 2a): The specimen is completely embedded in amber and seemingly complete. Only clearly visible from ventral view; dorsal view completely obscured by large air inclusion, most of lateral views also obscured. One wing almost completely spread out and clearly visible, other wing folded. Among other inclusions two Auchenorrhyncha.

Description. Body length: approx. 2.2 mm; wing length: 2.6 mm.

Female. Head. Anterior eye facets greatly enlarged (Fig. 2a). Third antennal segment acuminate; second antennal segment with few short bristly hairs below and above. Front and upper part of occiput not visible.

Thorax. Propleural fan absent. Mesonotum at lateral side with few dispersed moderately long hairs, dorsocentral hairs not visible, possibly completely reduced.

Legs simple and typical shape for genus (Fig. 2a). Femora, mid femur distinctly with developed ventral spines at apical part. Front and hind femora apparently with-

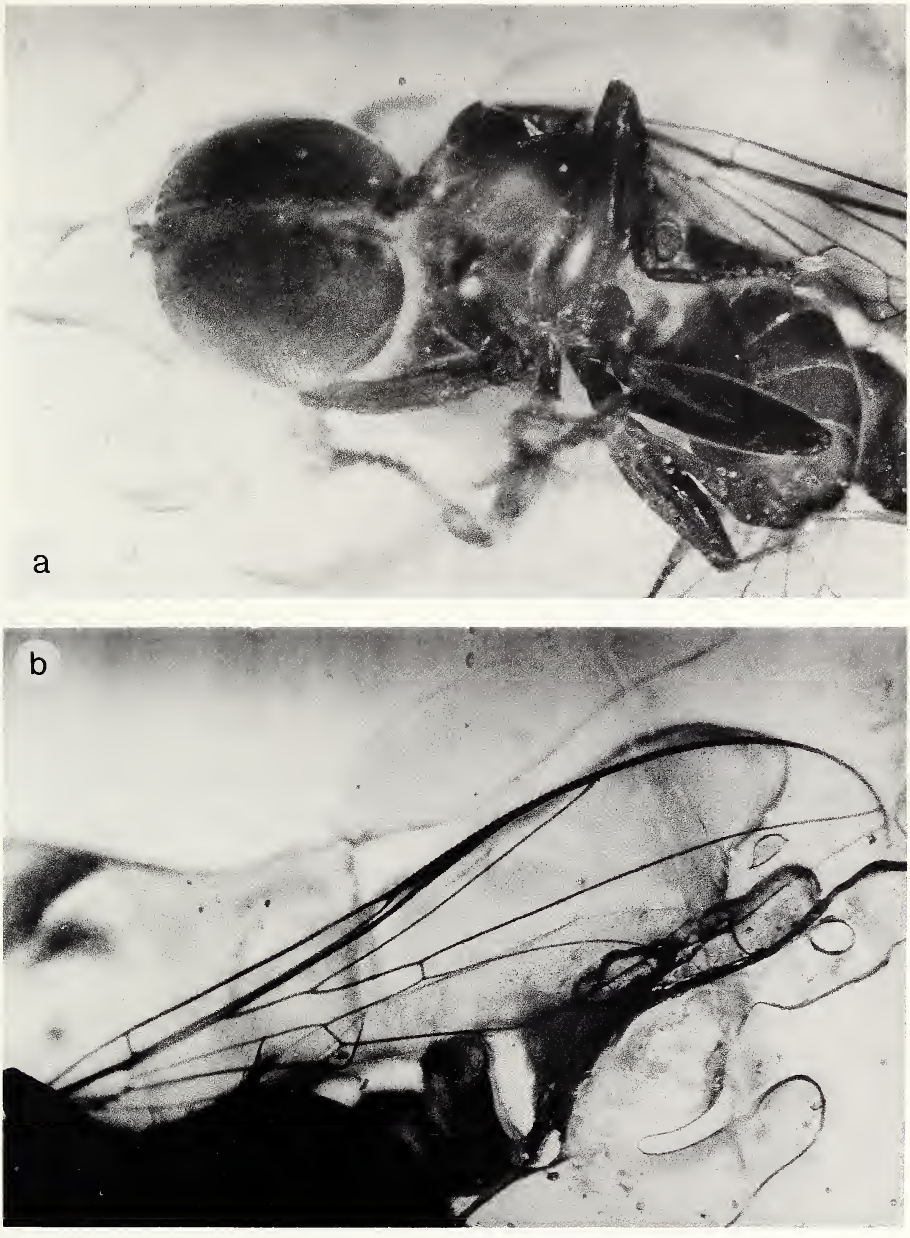

Fig. 2. *Eudorylas* sp. B. a: general habitus, ventrolateral lateral view. b: left wing, ventral view.

out well developed ventral spines. Femora seemingly darkened except narrowly apically. Tibiae without erected median bristle or apical spine. Pulvilli and claws larger than last tarsal segment.

Wings (Fig. 2b). Third costal section with pterostigma distinctly coloured over entire length of costal section. Fourth costal slightly shorter than third section. Cross-vein r-m at base of third section, approx. at basal third of discal cell. Vein M1+2 simple.

Abdomen. Lateral fan with well developed row of long darkish bristly hairs. Terga apparently without pilosity. Terminalia well developed with base longish and oblong, not bilobed; piercer about 1,5 times as long as base, slightly curved upwards.

Discussion. This female specimen also seems to have most of the characteristics of the genus *Eudorylas.* The propleural fan is absent and the pterostigma is distinctly coloured. Because of the restricted view, its position is not very clear. It seems to be related to the previous species based on the general morphology and the shape of the ovipositor, except for the small differences outlined above and the difference in size.

GENERAL DISCUSSION

As mentioned above, the pipunculid fossil record is very limited. In total, Aczél (1948) lists 12 known specimens. *Protonephrocerus florisantius* is the only specimen from Florissant Shales of Colorado (USA). All other fossils are preserved as inclusions in Baltic amber.

The most important fact of the recent findings in Dominican amber is the phylogenetic position of the specimens concerned. Recently Rafael and De Meyer (1992) proposed a generic classification of the Pipunculidae based on a cladistic analysis. In this they differentiated three subfamilies, with the Pipunculinae divided into five tribes (Fig. 3). All earlier fossil records monographed by Aczél (1948), belong to the more plesiomorphic groups Chalarinae and Nephrocerinae (Fig 3). The author could re-examine the florissant shale specimen during a recent visit to the Museum of Comparative Zoology, Cambridge (Massachusetts, USA). The impression is weak but is undoubtedly a pipunculid. Deducting from the size, general shape and shape of the head can it indeed most likely be placed in the subfamily Nephrocerinae. The other specimens could not be studied but Aczél's redescription and analysis is adequate to confirm subfamily or tribal position. Most known specimens belong to the genus *Verrallia* or a related plesiomorphic sister genus. Others belong to Nephrocerinae (genus *Nephrocerus* and *Metanephrocerus*). The only specimen of uncertain tribal position is *Cephalosphaera baltica.* As indicated in Rafael and De Meyer (1992), the specimen could well belong to *Parapipunculus* but air inclusions obscuring the dorsal view make a definite placement not possible. This would either put it in the Pipunculini or the Cephalopsini. Both specimens from Dominican amber clearly belong to a more apomorphic group, the Eudorylini.

Some hypotheses can be proposed with this respect to the evolution of the group. All Baltic amber specimens are estimated to be of Eocene or lower Oligocene origin (40–50 mill Yrs). Dominican amber is considered younger, from Oligo-Miocene origin (20–25 mill Yrs) (Grimaldi et al., 1994). This would explain why the older fossils predominantly represent older lineages and that more evolved groups like

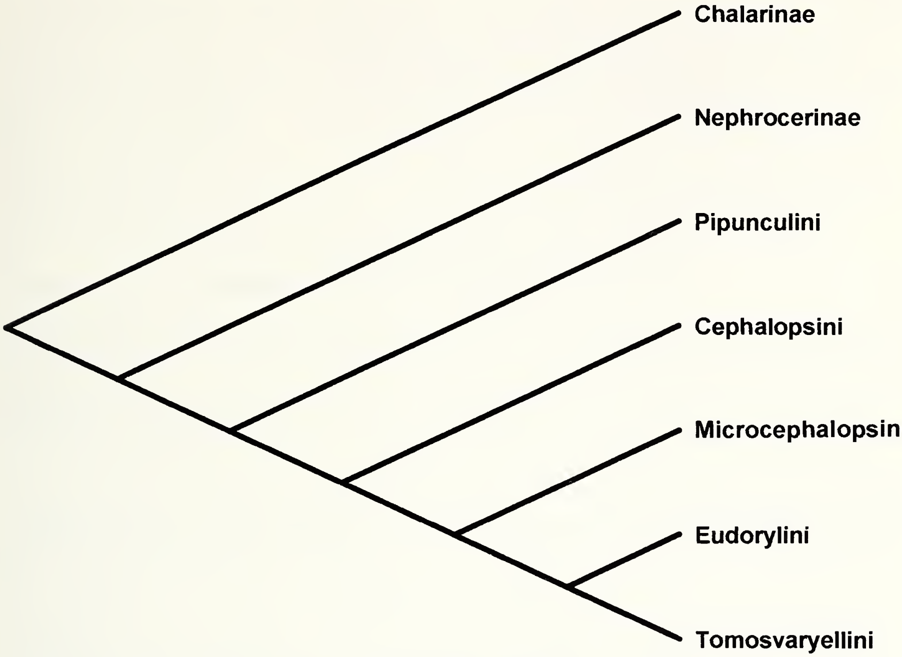

Fig. 3. Phylogenetic relationships within Pipunculidae.

Eudorylini could have been still absent in that period. The fossil record is however too limited to make definite conclusions.—*Marc De Meyer, Dept. Invertebrate Zoology, National Museums of Kenya, P.O. Box 40658, Nairobi, Kenya.*

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NOTES ON GASTERUPTIID WASPS (HYMENOPTERA: EVANIOIDEA)

The family Gasteruptiidae is a little-known group of parasitic wasps, easily characterized by the highly-placed articulation of the elongated metasoma on the propodeum. The family is divided into two subfamilies, the Hyptiogastrinae with five genera of Gondwanan distribution, and the Gasteruptiinae with one cosmopolitan genus (*Gasteruption* Latreille). Little is known about the biology of gasteruptiids, but all species for which host records exist are parasites of Apoidea s.l. (Townes, 1950; Malyshev, 1968; Mason, 1993). *Gasteruption assectator, G. jaculator,* and *G. pedemontanum* have been observed to rob from the cells of the megachiline bee *Megachile rotundata* (Megachilidae) in Russia (Narolsky and Shcherbal, 1991), and some Australian and New Zealand species are known to victimize bees of the families Colletidae and Stenotritidae (Jennings and Austin, 1994a, b). Adults of some species are thought to feed on pollen (Jennings and Austin, 1994b: 1292). Those species North of Mexico with recorded hosts all have been taken from nests of bees in the families Colletidae, Megachilidae, and Apidae (*sensu* Roig-Alsina and Michener, 1993). Outside of these few host records, the biology of nearctic species is completely unknown (Mason, 1993). Herein I present a new host record for *G. assectator arca* found in the cell of a megachilid bee in Central New York. *G. assectator* has previously been recorded in nests of *Hylaeus ellipticus* (Colletidae) and *Megachile rotundata* (Megachilidae) in North America (Krombein et al., 1979).

SUBFAMILY GASTERUPTIINAE, GENUS *GASTERUPTION* LATREILLE

Gasteruption assectator arca (Couper)

NEW HOST RECORD: Taken from *Hoplitis producta* (Cresson) cell (Hymenoptera: Megachilidae; Megachilinae). Nest dug into the pith of a twig. Cell Nr. 5, Cornell University Lot Nr. 1040, sub. site B, nest 111, Tompkins Co., NY, 28 April 1974, Suellen Vernoff. Cornell University Insect Collection.

SUBFAMILY HYPTIOGASTRINAE, GENUS *PSEUDOFOENUS* KIEFFER

Pseudofoenus pedunculatus (Schletterer)

LOCALITY: 1 male, New Zealand, North Island, South Auckland, Tahunanui, 14 January 1928, E. S. Gourlay. Cornell University Insect Collection.

Pseudofoenus is a problematic genus of hyptiogastrine wasps endemic to New Zealand. It has not been possible to associate the sexes based on morphology or locality; at present the two recognized female species are taxonomically distinct from two additional "species" known only from the male sex (Jennings and Austin, 1994b). For this reason it is noteworthy to report here a male and female *Pseudofoenus* collected at the same locality in New Zealand. The record of *Pseudofoenus pedunculatus* from South Auckland, North Island, is the second record of this species from the North Island and the first record from South Auckland.

Pseudofoenus unguiculatus (Westwood)

LOCALITY: 1 female, New Zealand, North Island, South Auckland, Tahunanui, 14 January 1928, E. S. Gourlay. Cornell University Insect Collection.—*Michael S. Engel, Department of Entomology, Comstock Hall, Cornell University, Ithaca, NY 14853.*

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PHORTICUS COLLARIS STÅL: A NABID NEW TO EASTERN NORTH AMERICA (HETEROPTERA: NABIDAE)

In the course of investigating the Heteroptera fauna of North Carolina I have collected *Phorticus collaris* Stål, a nabid previously unrecorded from east of the Mississippi River. This paper is presented to alert other collectors of Heteroptera to look for this uncommon and little-known species in their state and curators to look for it in their collections.

Since Stål's (1873) description of *P. collaris* from Texas, this little-known species has been reported from only one additional locality. Champion (1899) recorded *P. collaris* from Teapa, Mexico; a town located in the state of Tabasco in southern Mexico. The genus *Phorticus* is widely distributed throughout the world with 4 species known from South and Central America (Harris, 1928).

On 23 July 1992, I collected a single male of *P. collaris* at a black light in Raleigh (Wake Co.), North Carolina. Additional collecting at lights, approximately twice weekly for the remainder of the season yielded no additional specimens. The following year on 2 August 1993, I collected a single female again at a black light in Raleigh. Additional collecting yielded no further specimens in 1993, 1994 or 1995.

Phorticus collaris Stål
Fig. 1

Phorticus collaris Stål 1873: 109.

Redescription. Oblong, thickly clothed with more or less erect, long, light brown setae. Head and scutellum black. Pronotum black except for yellowish brown triangular spot extending from collar to middle of anterior lobe and median vitta on posterior lobe, acetabulum yellowish brown. Antennae black; rostrum with basal segment black, distal segments yellowish brown. Hemelytra with basal halves of clavus and corium and an area on disc of corium yellowish brown; apex of clavus and corium black; veins of clavus and corium punctate; membrane black except area bordering apex of corium and wing margin; veins distinct. Legs and abdominal venter yellowish brown.

Head with eyes large, sparsely yet distinctly pilose; ocelli prominent, widely separated and nearly in contact with eyes. Collum broadly exposed, shiny. Thorax granulose, appearing velvety. Pronotum with punctate transverse impression. Scutellum with sides sinuate, apical half swollen, disc bifoveate. Meso- and metapleuron with distinct median carina. Anterior femora strongly incrassate, armed with a ventral spine near middle and denticulate from there to apex. Anterior tibiae strongly widened apically, ventrally denticulate, with a distinct spongy fossa at apex. Abdomen with basal segment distinctly keeled medially; basal margins of segments punctate.

Measurements (in mm). Length 3.53–3.56, width of abdomen 1.23–1.33; head length, 0.47–0.49, width 0.47, vertex 0.19–0.22; antenna length, I, 0.22–0.23; II,

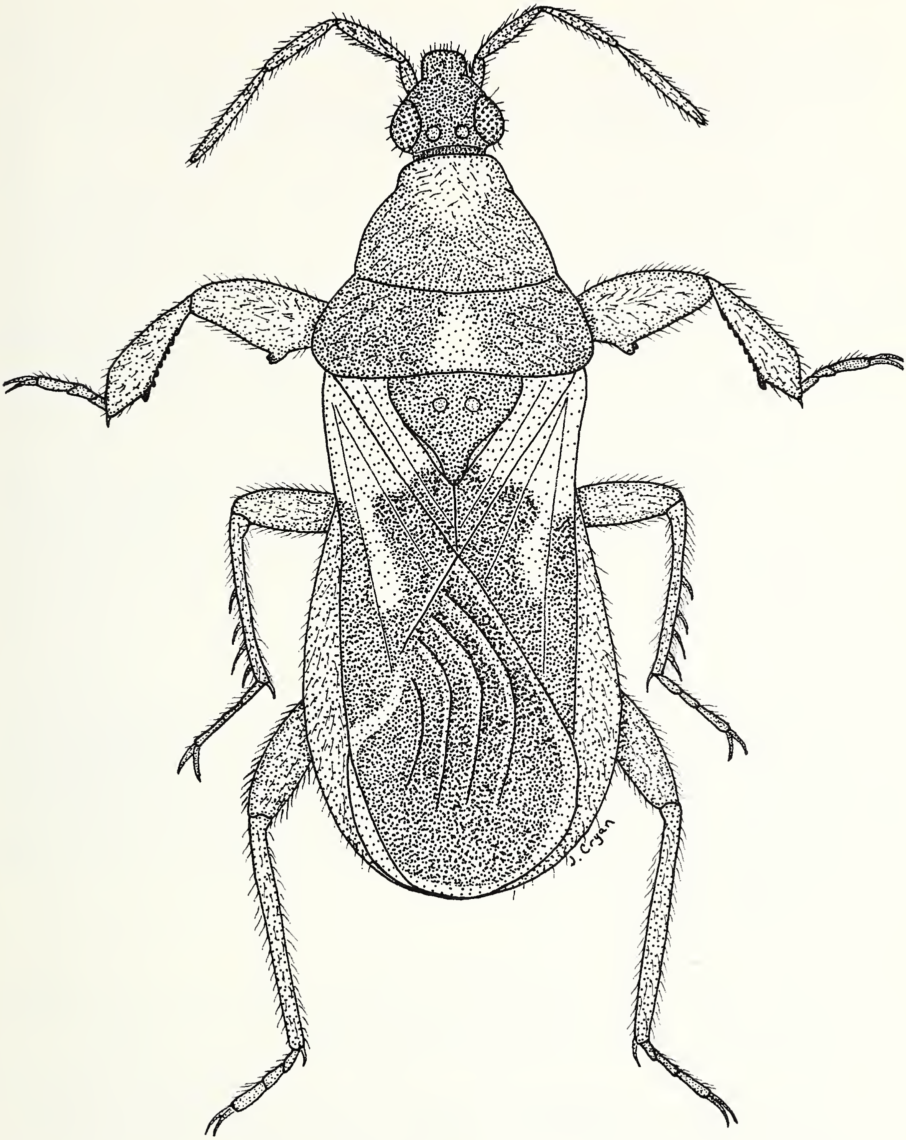

Fig. 1. *Phorticus collaris* Stål, dorsal habitus.

0.43; III, 0.44; IV, 0.53–0.56; rostrum length, I, 0.20–0.23; II, 0.54–0.56; III, 0.38; IV, 0.19–0.20; pronotum length, 0.99–1.01, humeral width, 1.14–1.19.

New Distribution Records. The following new records, extending the known range of *P. collaris,* are based on my personal collecting and material housed in the National Museum of Natural History, Washington, D.C. (USNM) and the Texas A&M

University Insect Collection (TAMU). Voucher material of the North Carolina specimens has been deposited in the North Carolina State University Insect Collection (NCSU).

NORTH CAROLINA: Wake Co., Raleigh, 23 July 1992 (1♂) and 2 August 1993 (1♀), collected at blacklight (NCSU). TENNESSEE: Hamilton Co., 24 June 1943 (1♂), 23 August 1943 (2♂), and (1♂) no date (USNM). TEXAS: Brazos Co., College Station, 10 October 1928 (1♂), 12 October 1928 (2♂), 5 November 1928 (1♂, 1♀) all collected at light traps; Hidalgo Co., 20 May 1930 (1♂), light trap, Weslaco, 20 May 1930 (1♀), 30 May 1930 (1♂), light trap, 5 June 1930 (1♀), light trap, 15 June 1931 (1♀) (TAMU).

Discussion. The above discription is based on the two North Carolina specimens. The specimens from North Carolina were compared with material determined as this species by H. M. Harris (no determination date). The Texas specimens differ from the North Carolina specimens in being more brown than black. This color difference is most likely due to fading in the older specimens over time.

This species is easily distinguished from the other American prostemmines by its small size, 4 segmented antennae and the presence of a ventral median keel on the basal abdominal segment. Both *Alloeorrhynchus* Fieber, 1860 and *Pagasa* Stål, 1862 have 5 segmented antennae and lack the median ventral abdominal keel.—*R. L. Blinn, Department of Entomology, North Carolina State University, Raleigh, NC 27695-7613.*

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NEW RECORDS FOR THE ANT *CHELIOMYRMEX MOROSUS* IN MEXICO (HYMENOPTERA: FORMICIDAE)

Cheliomyrmex is a rarely collected Neotropical genus of ants. The biology of these ants is almost unknown (Wheeler, 1909, 1921; Skwarra, 1934; Borgmeier, 1955). It is the only genus in the subfamily Ecitoninae that has the postpetiole broadly attached to the gaster and the mandibles are elongated with three well defined teeth. Its origin and phylogenetic position are unresolved (Borgmeier, 1955; Gotwald and Kupiec, 1975; Gotwald and Burdette, 1981; Snelling, 1981), although it is clearly a member of the subfamily Ecitoninae, based on several apomorphic characters (Bolton, 1990). Our objectives are to add two new localities for *Cheliomyrmex morosus* (Fr. Smith), discuss our observations of the biology of this species and to specify the type locality.

Cheliomyrmex morosus is found in Mexico and Central America (Honduras, Belize, Guatemala). It is the only species of the genus in Mexico (Watkins, 1982), previously reported from Campeche, Chiapas, Hidalgo, San Luís Potosí and Veracruz. We add two new localities: Veracruz, 5.6 K NE of Coscomátepec, Carretera Nacional 125, 5-vi-1988, 19°06′N, 97°01′W and Puebla, Teziutlán, 7-vi-1988, 1,940 m, 19°48′N 98°20′W. The first site is a coffee plantation, and at the second site there were two colonies, one in a grassland (*Pasoalum/Hilaria*) and the other colony was in a disturbed area of dense secondary forest (*Ouercus/Rubus*). All three areas were greatly disturbed as the original vegetation was mixed mountain forest (Rzedowski, 1978). Both localities were very wet and had recently received precipitation in the form of dew deposition or rains. This species is able to live in altered habitats. Both of our sites are surrounded by urban areas and coffee and corn crops.

This species was active on the surface of the soil from the afternoon (17:00–18:00 central Mexican time) throughout the night. One colony had thousands of workers and made a column several meters long under litter and through cracks in the soil. We did not observe a bivouac or other type of nest in the colonies. This is a very aggressive species. The mandibles easily penetrate the skin and the sting is very painful. A swelling and blister appear almost immediately. The pain subsides after a few hours in most cases.

There is confusion over the type locality of this species. Borgmeier (1955) mentioned that he could not find Atoyac in the state of Veracruz, and the type locality was probably in the states of Oaxaca or Jalisco. Atoyac is actually 15 K ENE of Córdoba, Veracruz, and is located at 18°56′N and 97°44′W, at an altitude of 525 m, an area of low forest with temporary agriculture.

We would like to thank the Texas Department of Agriculture for financial support and Emma MacKay for reviewing the manuscript. Approved as TA-23910 by The Texas Agriculture Experiment Station. Please direct requests for reprints to W. MacKay.—*David Gonzalez Villareal[1], William P. MacKay[2], Artemio Rebeles Manriguez[1] and S. Bradleigh Vinson[3], [1]Laboratorio de Entomología, Facultad de Biol-*

ogía, Universidad Autonóma de Nuevo León, San Nicolás de los Garza, N. L., México; [2]Laboratory for Environmental Biology, The University of Texas, El Paso 79968; [3]Department of Entomology, Texas A&M University, College Station 77843.

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A NEW NAME FOR *PSEUDOGRAMMA* CARPENTER (CALONEURODEA: PALEUTHYGRAMMATIDAE)

The extinct order Caloneurodea, characterized by the similarly shaped fore- and hindwings and in having veins CuA and CuP simple, is only known from Upper Carboniferous and Permian deposits (303-245 million years ago). The group is quite small with only 9 families and 16 genera (see Carpenter, 1992, for complete listing). Although some authors have suggested the Caloneurodea to be a basal neuropteroid order of the Endopterygota (Sharov, 1966; Rasnitsyn, 1980), the order is best considered a relative of the extinct order Protorthoptera in the Exopterygota (Burnham, 1984; Carpenter, 1992).

In 1943 Dr. Frank M. Carpenter erected a new genus, *Pseudogramma,* for the euthygrammatid species *Euthygramma aberrans* (Martynov, 1938). At that time, Carpenter also moved *Pseudogramma* into a new family, the Paleuthygrammatidae,

along with the genera *Paleuthygramma, Vilvia, Vilviopsis,* and *Apsidoneura. Apsidoneura* was later moved into its own family with *Homaloptila* (Carpenter, 1961). Unfortunately, the generic name *Pseudogramma* is preoccupied. Thus, the following taxonomic changes are proposed to alleviate this difficulty:

Paleuthygrammella, **new name**

Pseudogramma Carpenter, 1943, p. 70.; preoccupied by *Pseudogramma* Bleeker, 1875, p. 24 (Perciformes: Serranidae). Type species: *Euthygramma aberrans* Martynov, 1938, by original designation.

Etymology. The new generic name is a diminutive of *Paleuthygramma,* type genus of the family Paleuthygrammatidae.
Remarks. The genus is only known from the Upper Permian of Arkhangelsk Province, Russia and contains only the type species. The genus is distinguished from other paleuthygrammatid genera in having vein M simple.

Paleuthygrammella aberrans (Martynov), **new combination**

Euthygramma aberrans Martynov, 1938, p. 73.
Pseudogramma aberrans (Martynov): Carpenter, 1943, p. 70.

Remarks. This species is only known from the wings. The venation has most recently been figured by Martynova (1962) and by Carpenter (1992).—*Michael S. Engel, Department of Entomology, Comstock Hall, Cornell University, Ithaca, NY 14853.*

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BOOK REVIEWS

J. New York Entomol. Soc. 103(2):222–225, 1995

True Bugs of the World (Hemiptera: Heteroptera). Classification and Natural History.—Schuh, Randall T. and James A. Slater. Cornell University Press, Ithaca and London. xii + 337 pp. Price US$ 85.00.

This is one of the most important books on true bugs (Hemiptera-Heteroptera) ever published. The authors, Randall T. Schuh and James A. Slater, are some of the most distinguished contemporary heteropterists. Toby Schuh is currently George Willett Curator of Entomology at the American Museum of Natural History, New York, and the leading world specialist on plant bugs, Miridae, but has also greatly influenced modern views on the phylogenetic relationships of Heteroptera. Jim Slater is Professor Emeritus of Biology at the University of Connecticut, Storrs, and the leading specialist on seed bugs, Lygaeidae, as well mentor of several heteropterists including Toby Schuh.

A general account of true bugs is badly needed. Earlier general treatments on Heteroptera, like R. A. Poisson's chapter in "Traité de Zoologie" (1951) and K. H. C. Jordan's volume in "Handbuch der Zoologie" (1972) are largely outdated. Another recent attempt to treat all families of true bugs was N. C. E. Miller's "The Biology of Heteroptera" (1956, 2nd ed. 1971). However, this work concentrates on Miller's primary interest, the Reduviidae, while the treatments of all other families are brief and contain numerous factual errors. Finally, the accounts of heteropteran families in "The Hemiptera" by W. R. Dolling (1991) are restricted to the British fauna and are too deficient in its literature treatment to be of general use.

The book is aptly dedicated to two of the most distinguished heteropterists of our time, Pedro W. Wygodzinsky (1916–1987) and René H. Cobben (1925–1987), the latter being the author of the most comprehensive works on the comparative morphology of Heteroptera (Cobben 1968, 1978) which laid the foundation for the subsequent development of ideas on the phylogeny of Heteroptera.

Chapter 1 is a concise historical account of the study of the Heteroptera starting with earlier attempts at higher classification, especially Leon Dufour's divisions Amphibiocorisae (semiaquatic bugs), Hydrocorisae (aquatic bugs), and Geocorisae (terrestrial bugs), and ending with the modern, phylogeny-based classification in seven infraorders: Enicocephalomorpha, Dipsocoromorpha, Gerromorpha, Nepomorpha, Leptopodomorpha, Cimicomorpha, and Pentatomomorpha. The impact of cladistics on contemporary heteropteran classification was earlier reviewed by Schuh (1986) and the most notable later contribution is the work by Schuh and Stys (1991) on cimicomorphan family relationships. The evidence for the monophyly of the seven infraorders as well as most families appears solid, but a few paraphyletic families still remain, e.g., the Lygaeidae and most likely other pentatomomorphan families.

The author's view on the phylogenetic relationships between the heteropteran infraorders is based upon the study by Wheeler et al. (1993) where morphological and molecular data (18S rDNA-sequences) were combined in a "total evidence" cladogram depicting the sequence of relationships (Enicocephalomorpha (Dipsocoromor-

pha (Gerromorpha (Nepomorpha (Leptopodomorpha (Cimicomorpha (Pentatomomorpha). This scheme, however, is identical to the single most parsimonious tree derived from molecular data alone while the consensus tree based only on morphological data groups the Enicocephalomorpha, Dipsocoromorpha, and Gerromorpha together. (Andersen [1995] should be consulted for the correction of some errors in Wheeler et al. [1993] in their presentation of the cladistic hypothesis based on morphological data). The morphological evidence supporting the cladogram (their fig. 1.1) preferred by Schuh and Slater is not discussed in any detail but is distressingly weak. For instance, there are no synapomorphies supporting the group Leptopodomorpha + Cimicomorpha + Pentatomomorpha and the relationships of the Dipsocoromorpha and Gerromorpha relative to this group + Nepomorpha are also unsupported. I therefore share the authors' view (p. 5) that we must await additional evidence (morphological and molecular) to test the scheme proposed by Wheeler at al. (1993).

Chapter 2 contains biographical notes on now deceased influential or controversial workers on Heteroptera, including much useful information on bibliographies, locations of collections, types, etc. A more general account of "Sources of information" (Chapter 3) contains additional information on literature and collections. A mandatory Chapter 4 on "Collecting, Preserving, and Preparing Heteroptera" describes traditional methods as well as a few new ones like "canopy fogging", "ultrasonic cleaning", and "critical point drying".

Biological information on true bugs can be found in the systematic sections of the book (see below) but the Chapters 5–8 on "Habitats and Feeding Types," "Wing Polymorphism," "Mimicry and Protective Coloration and Shape," and "Heteroptera of Economic Importance" provide general overviews and highlights some of the most striking adaptations of heteropterous insects. Despite being one of the smallest of the "major" groups of insects (with about 38,000 described species), the true bugs utilize an enormously wide range of different habitat types, including such atypical ones as webs of spiders and Embioptera (Plokiophilidae), termite nests (Termitaphididae), and the surface of the open ocean (the sea skaters, *Halobates,* belonging to the Gerridae). Unlike the other hemipterous suborder, the Homoptera, true bugs forage on a wide array of food items, such as every part of seed plants (and a few ferns), fungi, other arthropods, and blood from vertebrates. Although plant-feeding species make up the majority of Heteroptera, the phylogenetic hypothesis (see above) suggests that this habit is secondarily acquired from predatory ancestors. Wing polymorphism is extremely common in the Heteroptera and the account on this phenomenon (Chapter 6) is quite extensive and well written. An additional chapter on "Reproductive Biology" would seem appropriate here in light of many well studied groups exemplifying parental care (Belostomatidae), traumatic (hemicoelic) insemination (Cimicoidea and some Nabidae), sexual dimorphism and different mating strategies (several groups), etc.

The section on "Historical Biogeography" (Chapter 9) has clear introductory statements on the principles of historical (cladistic) biogeography as well as brief summaries of distributional patterns characteristic of each of the major zoogeographical regions.

As introduction to the descriptions of infraorders, families, and subfamilies of Heteroptera, a general account of morphology is provided (Chapter 10). This section

is necessarily brief, but numerous references to the extensive literature on the subject make this an excellent introduction to the structural diversity of bugs. A key to the infraorders of Heteroptera (p. 65) concludes the chapter. I doubt, however, that this key will be useful as starting point for the identification of unsorted bug specimens. A survey of the many excellent habitus figures in the systematic chapters would probably put the user on the right track in most cases and enable him or her to continue through one of the family-keys.

The remaining 218 pages of the book (Chapters 11–92) are devoted to the systematic treatments. Taxa are grouped by infraorder, superfamily, family, and subfamily. Diagnoses are provided for all categories except superfamily. The structure of information presented for each family is standardized for most parts, with a general introduction, diagnosis, classification, specialized morphology, natural history, and distribution and faunistics. Keys are provided for families and subfamilies. The strictly uniform format followed for each family is one of the major strengths of this book. It allows the reader to extract comparative information on morphology, taxonomic diversity, natural history, distribution, etc., which again may be an inspiration for those who want to explore patterns of diversification and their probable causes. For instance, it is noteworthy that the "litter" habitat predominates (at least primitively) in the infraorders which are believed to be most basal in the heteropteran phylogeny (Enicocephalomorpha, Dipsocoromorpha, Gerromorpha). These three infraorders as well as the Nepomorpha and Leptopodomorpha contain only predaceous forms (the only exception being the chiefly detritus-feeding Corixidae). It is also interesting that the most speciose families comprise both predaceous (Reduviidae) and chiefly phytophagous forms (Miridae, Pentatomidae, Lygaeidae), but that the predatory habit has evolved (probably secondarily) in subgroups of the primarily plant-feeding families. In all, phytophagy appears to be a much more flexible strategy in the Heteroptera than in other phytophagous insect groups, including the Homoptera.

The book is profusely illustrated. The illustrations include beautiful habitus drawings of representatives of each family, numerous figures showing structural details of special relevance for each group, and several plates of SEM-micrographs showing details of legs, sensory and glandular structures, stridulatory structures, specialized hair structures, etc. The quality of reproduction of the photographs is excellent, revealing a microscopic world of great beauty. The SEM-pictures are original to this work while most other illustrations are reproduced (with due acknowledgements) from the extensive literature covered by the authors.

The book is concluded with an extensive (31 pages) list of references covering all pertinent literature on the systematics, morphology, natural history, distribution, and faunistics of Heteroptera. This list is one of the most useful features of any handbook and I have not been able to discover any significant omissions. A Glossary of (chiefly morphological) terms is provided as a useful supplement to the Index. The only thing missing is perhaps a sort of check-list of higher category names (to subfamily level), useful for museum curators of Heteroptera.

The book is very handsomely bound and its price is not unreasonable following today's standard. In conclusion, Toby Schuh and Jim Slater have done a marvelous job compiling an exemplary handbook which adequately covers one of the most diverse groups of insects. All heteropterists, most entomologists, and a lot of other

biologists welcome this outstanding handbook on True Bugs of the World which has been missing for a very long time.—*Nils M. Andersen, Zoological Museum, University of Copenhagen, Universitetsparken 15, DK-2100 Copenhagen, Denmark.*

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ALL ABOUT THE MARAUDERS OF THE JUNGLE

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Army Ants: The Biology Of Social Predation.—William H. Gotwald, Jr. 1995. Cornell University Press, Ithaca. xviii + 302 pp. ISBN 0-8014-2633-2. Hard cover, £31.50.

When I met Gotwald in 1985 at the annual meeting of the French-speaking section of the International Union for the Study of Social Insects in Diepenbeek, I was a young, enthusiastic student in ant systematics. I found myself somewhat betrayed, as I was not allowed to study those fantastic, tropical ants I was reading about in novels such as *Marabunta* by Stephenson, dealing with those ferrocious ants which threatened even the life of the pioneers out in the Amazonian jungle. And here was Bill Gotwald, specialist in those beasts. When I asked him about how it feels to be out there in the jungle to study army ants, he answered with some disappointment, that he has no 'lust' anymore, to be out there in the bush, to run all day long following tracks and not to see a lot. At least not enough to satisfy the National Science Foundation, which supported his projects. I was perplexed, to say the least.

Now, 10 years later, assured by my own field experience that army ants are definitely the *non plus ultra* of things to meet out there in the jungle, I wonder what Gotwald has to tell us in his new book on army ants. Expectations are high, especially as he has chosen the same title as the pioneer in army ant research, T. C. Schneirla, in his 1971 volume *Army Ants.* This sounds very familiar. Didn't Hölldobler and Wilson (1990) recently publish a Pulitzer Prize winning book, *The Ants,* and replacing with it *Ants* by the former master myrmecologist William Morton Wheeler, first published in 1910, but still available in book stores (Wheeler, 1910)? Both the army ant books have the same format, so what is different? Maybe there is a difference, as Schneirla used a subtitle "*A study in Social Organization*" whereas Gotwald changed that into *The Biology of Social Predation.*

Schneirla produced the largest part of the information in his book by himself. Gotwald is synthesizing a lot of work produced by other workers, especially the systematics and behavior. The systematics of army ants had a brilliant treatment by Bolton (e.g., Bolton, 1990), which finally led to the (only) well corroborated army ant clade within the ant phylogeny, and to the erection of five army ant subfamilies (doryline section): Aenictinae, Aenictogitinae, Dorylinae, Ecitoninae, Cerapachyinae, and Leptanilloidinae (Baroni et al., 1992). This publication, the first and most important study to use a complete data set for all the subfamilies, is included in the references, and is duly suppressed in the text of the systematics section. Franks probably contributed most during the last twenty years on the behavioral side, mainly by studying the Neotropical ecitonines on Barro Colorado Island, and in the Peruvian Amazon (see references in the book).

How then is the synthesis? Sloppy as concerns systematics, the base for the very much evolutionary approach chosen in this book. Gotwald talks about evolution of army ants, adaptive syndromes, and he does not deal with a monophyletic group, the army ants, which all arose from a common ancestor! In his figure 2.1, he shows a phylogeny of the ants, where the Cerapachyinae are more closely related to the Dorylinae and Aenictinae then are the Ecitoninae. But in the book, his army ants exclude Cerapachyinae. How then can you talk about an adaptive syndrome of army ants as opposed to convergent evolution of army ant behavior in ants such as some ponerines or the Leptanillinae? How can you choose an outgroup (Cerapachyinae) to understand the direction of the evolution of certain characters, which is in fact part of the group itself? This does not make sense to a well informed reader; it is just another nice story. It is even more painful, because Gotwald got his basic training as a morphologist (Gotwald, 1969) among systematists (E. O. Wilson and W. L. Brown, Jr.).

Flipping through the drawings and pictures, both in Schneirla (1974) and in Gotwald's book, it is obvious that there is not much new documentation around. Most of the pictures were taken by Rettenmeyer, and in fact replace those in Schneirla only in quality, but not always in having a more instructive content. I think Schneirla still has the best picture of an army ant bivouac.

The strength of this book is more in bringing together a lot of information, which is otherwise widely scattered. The chapters on "Guests and Predators," "The Role Of The Army Ant In Tropical Ecosystems" and on "Myth and Metaphor," make up the flesh of the book. It is not so evident, but here is the largest and most detailed source as to why ants actually are important. Everybody agrees that ants are probably

one of the most dominant animal taxa, but besides very few, well-known sources such as the study by Fittkau and Klinge (1973), there are not a lot of data easily available, such as the well hidden study by Erwin (1989). The same holds true for a summary on the myth of army ants. Anybody visiting a national park anywhere in the tropics will return with some stories about army ants. But then again, it is difficult to find such stories collated in a book.

I am negative about the book in a scientific way, but then I am positive about the later sections, and the photographic documentation, which make it worthwhile to have a copy of it on your own bookshelf.—*Donat Agosti, Department of Entomology, American Museum of Natural History, Central Park West at 79th Street, New York, NY 10024-5192, U.S.A.*

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INSTRUCTIONS TO AUTHORS

The *Journal of the New York Entomological Society* publishes original research resulting from the study of insects and related taxa. Research that contributes information on taxonomy, classification, phylogeny, biogeography, behavior, natural history, or related fields will be considered for publication. The costs of publishing the Journal are paid by subscriptions, membership dues, page charges, and the proceeds from an endowment established with bequests from the late C. P. Alexander and Patricia Vaurie.

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EWARTITHRIPS NEW GENUS (THYSANOPTERA: THRIPIDAE) AND FOUR NEW SPECIES FROM CALIFORNIA

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Abstract.—A new genus, *Ewartithrips,* and four new species, *E. californicus, E. dispar, E. flavidus* and *E. salviae,* are described from California. *Tenothrips ehrhornii* and *Taeniothrips longirostrum* are reassigned to *Ewartithrips* (NEW COMBINATIONS). A key is proved for identifying eight genera to which former nearctic *Taeniothrips* species were reassigned.

Key words: Thysanoptera, Thripidae, *Ewartithrips,* new genus, new species, new combinations.

Since the generic concept of *Taeniothrips* was revised (Mound et al., 1976; Bhatti, 1978), most species in the genus have been reassigned to other genera. In the latest reassignment of a Nearctic *Taeniothrips* species by Bhatti (1990), *Taeniothrips ehrhornii* (Moulton) was assigned to *Tenothrips.* Although *ehrhornii* is anatomically similar to *frici* (Uzel), the type species of *Tenothrips,* I conclude that they are not congeneric. The current generic assignment of *Taeniothrips longirostrum* (Jones) from California is also incorrect, and this species and *ehrhornii* are congeneric. Thus, *ehrhornii, longirostrum* and four new species, *californicus, dispar, flavidus* and *salviae,* are assigned here to a new genus *Ewartithrips.* The six species occur only in California except for *californicus* which also occurs in Baja California, Mexico. The only species remaining in *Taeniothrips* in the Nearctic Region are *eucharii* (Whetzel). *orionis* Treherne and *inconsequens* (Uzel).

METHODS AND TERMINOLOGY

The following terms are used for the reduced forewings in *dispar.* Brachypterous forewings = short, oval. Micropterous forewings = reduced to a small lobe or a stub with several setae.

Pigmented facets of the compound eye (Fig. 34): When pigmented ommatidial facets are present, 2 lateral marginal and 1–5 ventral facets are usually pigmented in a distinct pattern.

Campaniform sensilla are small porelike structures which are present on the abdominal tergites (Fig. 18B) and present or absent from the mesonotum (Fig. 12) and metanotum (Fig. 16).

Some of the anatomical structures used in this study are indicated on the following figures.

Chaetotaxy of head—Figure 4. Major setae on pronotum—Figure 11. Setae and campaniform sensilla on abdominal tergite—Figure 18. Posteromarginal comb on abdominal tergite VIII—Figure 22. Anteromedian setae on abdominal sternite I—Figure 23. Posteromarginal setae on sternite VII—Figure 25. Chaetotaxy and cam-

paniform sensilla on male tergite IX—Figure 29. Glandular area on male abdominal sternite—Figure 31.

The measurements of the structural characters are given in microns except for body length, which is in millimeters. Measurements and number of anatomical structures of the holotype or lectotype in a description are given first, followed by those of the paratypes and identified material in parentheses. However, the measurements of the antennal segments may be presented differently and are explained in the text.

Acronyms of the depositories of types and examined material: CAS = California Academy of Sciences; CDFA = California Department of Food and Agriculture, Sacramento; FSCA = Florida State Collection of Arthropods; SMF = Forschungsinstitut Naturmuseum Senckenberg, Frankfurt am Main; BMNH = The Natural History Museum, London; UNAM = Universidad Nacional Autonoma de Mexico, Mexico City; UCD = University of California at Davis; UCR = University of California, Riverside; and USNM = United States National Museum of Natural History, Washington D.C.

TAXONOMY

Members of *Ewartithrips,* NEW GENUS, have similar anatomical structures to some former *Taeniothrips* species now assigned to several genera. *Ewartithrips* is most similar to *Tenothrips* and *Ceratothrips.* The three genera belong in the *Megalurothrips* genus group, Thripina-Thripini, of Mound and Palmer (1981). The similar structures are: Antennae 8-segmented, segments III and IV each with a forked trichome; head with three pairs of ocellar setae; pronotum with two pairs of posteroangular setae; metanotum reticulated medianly and the median pair of setae on or near anterior margin except further posterior on micropterous form; abdominal tergites lack ctenidia; and the median tergal setae far apart. The structural characters differentiating these genera are treated in the following key.

An updated key to the genera of Thripidae for the continental United States and Canada is unavailable. *Ewartithrips* species will run to *Taeniothrips* in couplet 36 of the generic key in Stannard (1968). The following key differentiates most of the genera to which former nearctic *Taeniothrips* species were reassigned.

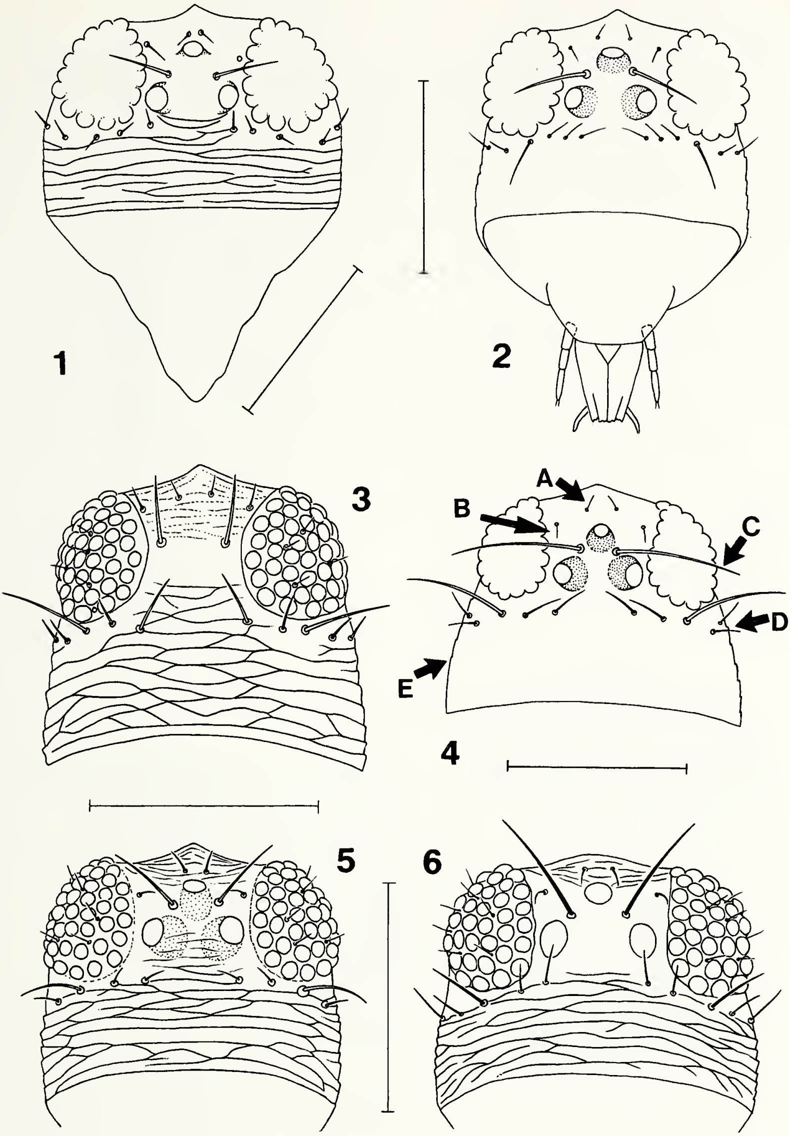
KEY TO GENERA

1. Pronotum with 1 pair of posteromarginal setae; forewing with few setae on hind vein and fringe cilia straight . . . . *Catinathrips*
   Pronotum with 2 or more pairs of posteromarginal setae (Fig. 11C); forewing, when developed, with a row of setae on hind vein and fringe cilia wavy 2

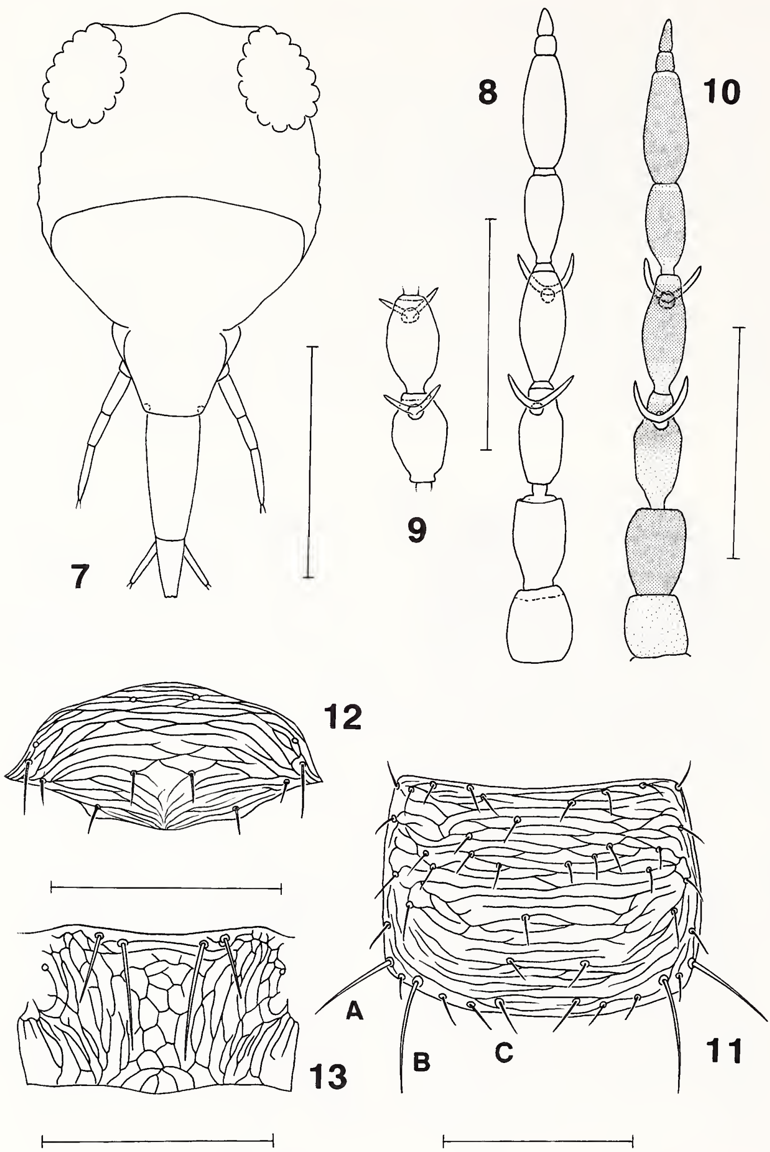
2(1) Head with 2 pairs of ocellar setae 3
   Head with 3 pairs of ocellar setae (Fig. 4A–C) 5

3(2) Abdominal tergite VIII without posteromarginal comb; tergite IX lacks campaniform sensilla; forewing with 2 distal setae on fore vein; male with a pair of long processes on abdominal segment IX (Fig. 33A) . . . . *Dorcadothrips*
   Abdominal tergite VIII with complete or medially interrupted comb; tergite IX with campaniform sensilla; forewing with 2 or more distal setae on fore vein; male without process on abdominal segment IX 4

4(3) Abdominal tergites V–VIII with pair of ctenidia (Fig. 32A); tergite VIII with complete or medially interrupted posteromarginal comb . . . . *Thirps*



Figs. 1–6. Heads, ♀. 1. *E. californicus*. 2. *E. ehrhornii*. 3. *E. dispar* micropterous form. 4. *E. dispar* brachypterous form. A. ocellar setae I; B. ocellar setae II; C. ocellar setae III; D. postocular setae; E. cheek. 5. *E. salviae*. 6. *E. flavidus*. Scale for figures = 0.1 mm. Same scale for Figures 8 and 9, and 20 and 21. No scale for Figures 32-35.



Figs. 7–13. 7. Head of *E. longirostrum* ♀. 8. *Antenna of E. dispar* macropterous ♀. 9. Antennal segments III and IV of *E. dispar* micropterous ♀. 10. Antenna of *E. flavidus* ♀. 11. Pronotum of *E. flavidus* ♀. 12. Mesonotum of *E. salviae* ♀. 13. Metanotum of *E. flavidus* ♀.

Abdominal tergites without ctenidia; tergite VIII with complete posteromarginal comb (cf. Fig. 22A) . . . . *Taeniothrips*

5(2) Forewing with 2 setae in distal half of fore vein; abdominal tergite VIII with complete posteromarginal comb (cf. Fig. 22A); eye with 5 pigmented facets (cf. Fig. 34) 6

Forewing with 3 or more setae in distal half of fore vein or wing brachypterous, micropterous or absent; other characters various 7

6(5) Pronotum with 3–4 pairs of posteromarginal setae (cf. Fig. 11C); abdominal sternite VII with B1 and B2 setae cephalad of posterior margin; male with many small glandular areas on abdominal sternites III–VII . . . .*Pezothrips*

Pronotum with 2 pairs of posteromarginal setae; abdominal sternite VII with only B1 setae cephalad of posterior margin (cf. Fig. 25A); male with an elliptical glandular area on each abdominal sternites III–VII. . . . . *Mycterothrips*

7(5) Eye with 5 pigmented facets (cf. Fig. 34); abdominal pleurotergite II with a short seta near anterior margin (cf. Fig. 35A); tergite VIII with medially incomplete posteromarginal comb . . . . *Tenothrips*

Eye without pigmented facets; abdominal pleurotergite II without small seta, only rarely on one side; tergite VIII with posteromarginal comb present or absent 8

8(7) Abdominal sternite VII with B1 setae cephalad of posterior margin (Fig. 25A); tergite VIII with posteromarginal comb complete (Fig. 22A), except *dispar* (Fig. 28); forewing with 3–8 distal setae on fore vein; male with 1 glandular area on each abdominal sternites III–VI or VII . . . .*Ewartithrips* n. gen.

Abdominal sternite VII with B1 setae on posterior margin; tergite VIII without posteromarginal comb; forewing normally with 3 distal setae on fore vein; male with 3 glandular areas on each abdominal sternites III–VII . . . . *Ceratothrips*

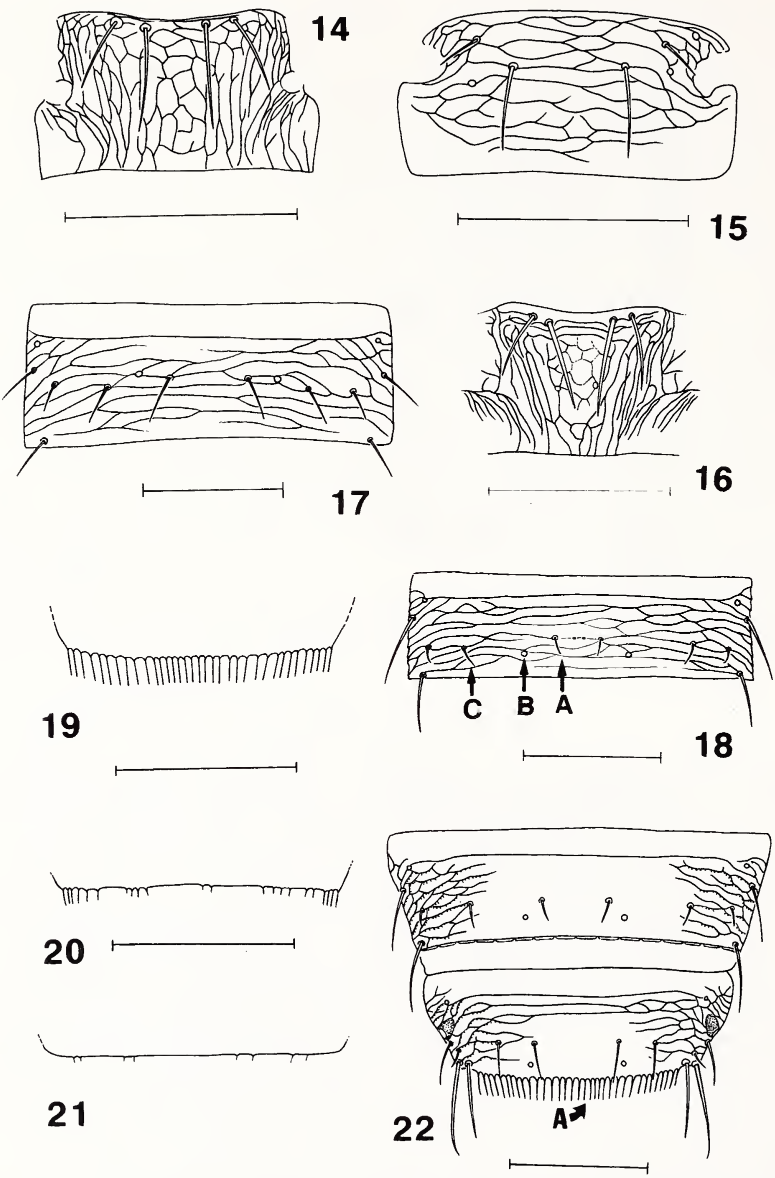
Ewartithrips, new genus

Type species. *Euthrips ehrhornii* Moulton.

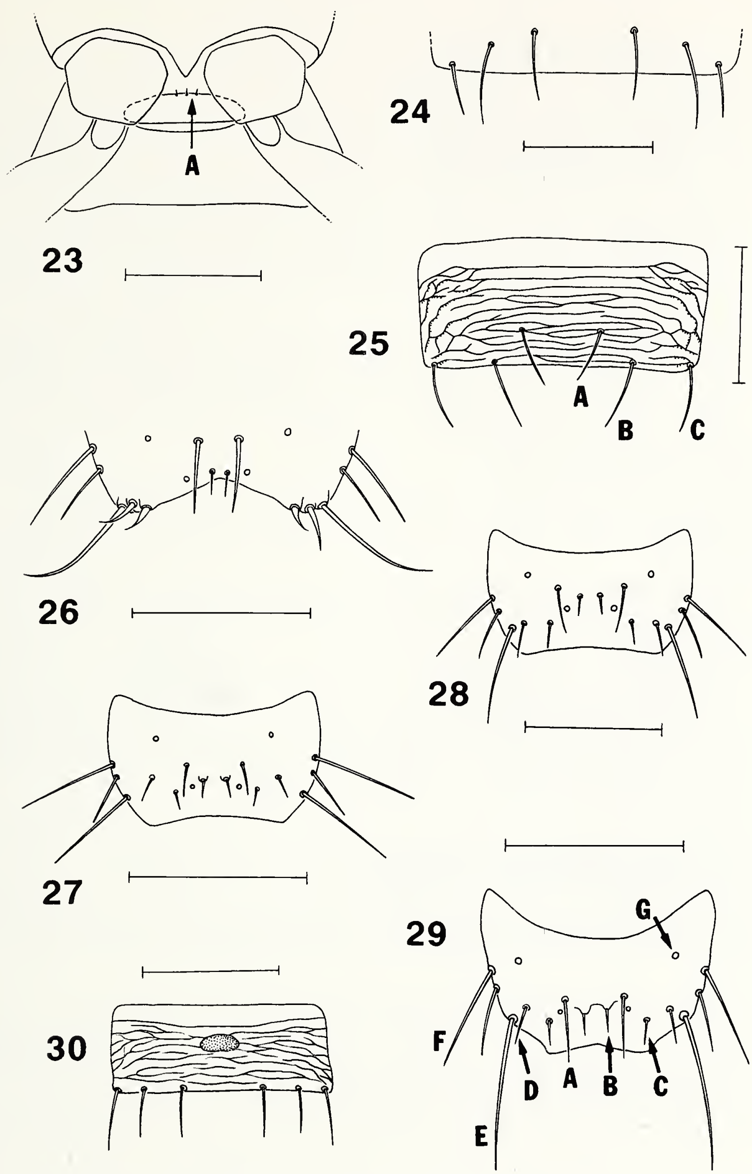
Female: *Antenna:* 8-segmented, segments III and IV each with a forked trichome. *Head* with 3 pairs of ocellar setae, setae I aligned transversely; postocular setae 5 or 6 pairs, with 3rd or 4th seta longest; eyes with dorsal ommatidial facets similar in size, pigmented facets absent; maxillary palps 3-segmented. *Pronotum*: Wider than long; 2 pairs of well developed posteroangular setae; posteromarginal setae normally 3 pairs, median pair largest; basantra without setae; ferna complete; prospinasternum a transverse band, spina tuberculate posteromedially. *Mesonotum*: Submedian setae far anterior of posterior margin; sternum with well developed furca and spinula; mesopraesternum with anteromedial tooth that inserts into spina. *Metanotum*: Median setae on or near anterior margin, further posterior in micropterous form; sternum with well developed furca, spinula absent. *Forewing*: Macropterous, brachypterous, or micropterous. *Abdomen*: Median setae far apart; posteromarginal comb complete on tergite VIII with microtrichia well-developed and close-set, except short, sparse or absent in *dispar*; tergite IX with 2 pairs of campaniform sensilla; tergite X almost divided by dorsal split; pleurotergite II without short seta near anterior margin; sternite I with short, anteromedian setae; accessory sternal setae absent.

Male macropterous or micropterous: Abdominal tergite IX with B1 setae bristle-like; sternites with elongate, oval, or circular glandular areas.

Etymology: This genus is named in honor of William H. Ewart, retired thysanopterist and former Professor at the University of California at Riverside, who collected much of the material in this study.



Figs. 14–22. 14. Metanotum of *E. dispar* macropterous ♀. 15. Metanotum of *E. dispar* micropterous ♀. 16. Metanotum of *E. californicus* ♀. 17. Abdominal tergite IV of *E. dispar* micropterous ♀. 18. Abdominal tergite VI of *E. salviae* ♀. A. medium or D1 setae; B. campaniform sensillum; C. D2 seta. 19. Posteromarginal comb on abdominal tergite VIII of *E. ehrhornii* ♀. 20 and 21. Posteromarginal comb on abdominal tergite VIII of *E. dispar* ♀. 22. Abdominal segments VII and VIII of *E. flavidus* ♀. A. posteromarginal comb.



Figs. 23–30. 23. Abdominal sternite I of *E. salviae* ♀. A. anteromedian setae. 24. Abdominal sternite VII of *E. californicus* ♀. 25. Abdominal sternite VII of *E. flavidus* ♀. 26–29. Abdominal tergite IX, ♂. 26. *E. californicus.* 27. *E. dispar.* 28. *E. flavidus.* 29. *E. salviae.* A. D1 seta; B. B1; C. B2 seta; D. B3 seta; E. posterolateral seta; F. midlateral seta; G. campaniform sensillum. 30. Abdominal sternite IV of *E. flavidus* ♂.

KEY TO SPECIES OF EWARTITHRIPS

1. Females 2
Males 7

2(1) Abdominal sternite VII with B1-B2 setae anterior of posterior margin (Fig. 24); postocular setae short, subequal in size (Fig. 1) . . . . *californicus* n. sp.
Abdominal sternite VII with only B1 setae anterior of posterior margin (Fig. 25); usually 1 pair of postocular setae distinctly longer than others (Fig. 4) 3

3(2) Posteromarginal comb on abdominal tergite VIII short, microtrichia sparse or absent (Figs. 20, 21); macropterous, brachypterous or micropterous . . . . . *dispar* n. sp.
Posteromarginal comb on abdominal tergite VIII well-developed, complete (Fig. 22); macropterous 4

4(3) Antennal segment VI yellow in basal ½; abdominal tergites sculptured completely (Fig. 18), sculpture weaker on intermediate and posterior tergites . . . . .*salviae* n. sp.
Antennal segment VI brown; abdominal tergites without median sculpture on intermediate and posterior tergites 5

5(4) Body predominantly yellow . . . . *flavidus* n. sp.
Body predominantly brown 6

6(5) Mouthcone elongate conical or prementum to apex subcylindrical, extending into mesosternum (Fig. 7), 148–165 μm long; maxillary palps 52–57 μm long; on lupins . . . . *longirostrum* (Jones)
Mouthcone conical, extending to position between procoxae (Fig. 2), 124–136 μm long; maxillary palps 42–47 μm long; various hosts . . . . *ehrhornii* (Moulton)

7(1) Micropterous . . . . *dispar* n. sp.
Macropterous 8

8(7) Abdominal tergite IX with B1 setae medially near posterior margin, B2 setae thicker basally, strongly tapered distally (Fig. 26) . . . . *californicus* n. sp.
Abdominal tergite IX with B1 setae between or posterior of D1 setae, B2 setae slender, bristlelike (Fig. 29) 9

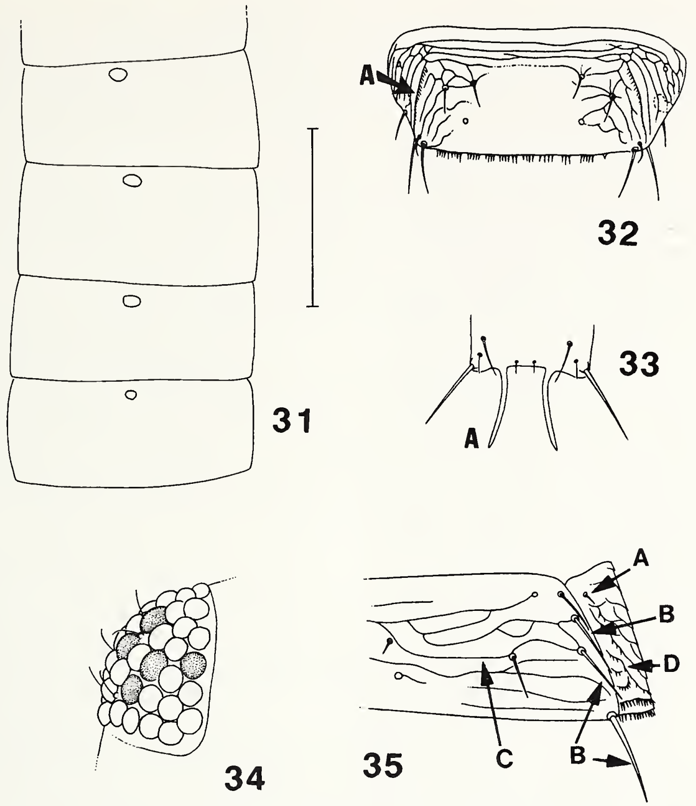
9(8) Antennal segment III, IV, most of V and basal ½ of VI yellow; 3rd postocular seta longest . . . .*salviae* n. sp.
With different combination of characters 10

10(9) Body predominantly yellow; abdominal sternites III–VII each with a small circular glandular area . . . . *flavidus* n. sp.
Body brown; abdominal sternites III–VI with a glandular area, absent from VII (Fig. 31) 11

11(10) Mouthcone conical, extending posteriorly to position between procoxae, 94–104 μm long; mandible 86–100 μm long; maxillary palp about 37 μm long; various hosts . . . .*ehrhornii* (Moulton)
Mouthcone elongate, extending posteriorly to mesosternum, about 131 μm long; mandible 131 μm long; maxillary palps 47–57 μm long; on lupins . . . . *longirostrum* (Jones)

Ewartithrips californicus, new species
(Figs. 1, 16, 24, 26)

Female (macropterous): Body brown or yellowish brown with yellow internal pigments; legs with all tarsi yellow, foretibia yellowish brown, mid- and hindtibia brown or with apex yellowish brown, femora brown, or all tibiae and femora yellowish brown; forewings light brownish yellow, base pale; major setae light brown; ocellar



Figs. 31–35. 31. Glandular areas on abdominal sternites III–VI of *E. longirostrum* ♂. 32. Abdominal tergite VIII of a *Thrips* species. A. ctenidia. 33. Abdominal tergite IX of ♂ *Dorcadothrips* species. A. elongate process. 34. Facetal pigmentation of the eye of *Thrips nigropilosus* Uzel. 35. Tergite and pleurotergite of abdominal segment II of a *Thrips* species. A. short seta near anterior margin; B. lateral setae; C. tergite; D. pleurotergite.

crescent orange; antennae brown except apex of segment II yellowish brown, basal $\frac{1}{2}$ of III yellow, basal $\frac{1}{4}$ of V and base of VI yellowish brown.
Antenna: Segment III about 2.3 times as long as wide, constricted apical part short; forked trichome on III–IV strongly divergent, V-shaped, 22 (24) μm long on IV; inner sense cone on VI extending to apex of segment or basal part of VII, 20 (17–22) μm long.
Head (Fig. 1): Wider than long, cheeks slightly arched; occiput about $\frac{3}{5}$ as long as eye, transversely sculptured. Three small, anteromedial tubercles present or absent cephalad of fore ocellus. Ocellar setae III between fore and hind ocelli, inside or on border of ocellar triangle; postocular setae 5 pairs, subequal in length. Mouthcone conical; mandible 124 (104–131) μm long; maxillary palps 47 (50) μm long.
Pronotum: About as long as head, with rather broad anastomosing transverse striae. Discal setae 37 (31–38) present; outer posteroangular setae $\frac{1}{3}$–$\frac{2}{5}$ as long as pronotum,

inner pair considerably longer than outer pair, slightly less than ½ to ⅔ as long as pronotum; posteromarginal setae 3 pairs, occasionally total of 5 or 7. *Mesonotum*: With transverse anastomosing sculpture; 2 anteromedial campaniform sensilla present. *Metanotum* (Fig. 16): Reticulated, medial reticles irregular and rather broad, laterally with longitudinal sculpture lines; median setae on anterior margin; 2 campaniform sensilla medially on notum.

Forewing: Straight, pointed apically; 29–32 (27–33) costal setae, those at midlength shorter than width of wing; 26–29 (24–28) straight anterior fringe cilia; fore vein with 7–8 (8–9) setae in proximal ½, 6 (6–8) setae in distal ½; hind vein with 14 (13–16) setae; scale with 5 marginal and 1 discal setae.

Abdomen: Abdominal tergites III-VIII without sculpturing between median setae, submarginal sculpture lines with minute microtrichia; median setae on tergites II–VI shorter than D2 setae, slightly anterior of median campaniform sensilla; tergite II with 3 lateral setae; posteromarginal comb on tergite VIII complete with 30–36 close-set microtrichia varying in length up to 20 μm long; tergite IX about as long as tergite X. Sternite I with 2–3 anteromedian setae (cf. Fig. 23); sternite VII with B1-B2 setae anterior of posterior margin, B1 setae further anterior than B2 setae, closer to B2 setae than to each other (Fig. 24).

Male (macropterous): Similar to female in color and most morphological characters, but smaller.

Body length 1.15–1.42 mm, distended. *Antenna*: Length 246–262 μm. *Head*: Mandible 100 μm long; maxillary palps 35–42 μm long. *Pronotum*: Posteroangular setae outer pair considerably shorter than inner pair. *Abdomen*: Tergite VIII with complete posteromarginal comb, microtrichia close-set. Tergite IX with posterior margin emarginate (Fig. 26); D1 setae thick, bristlelike; B1 setae close-set, medially near posterior margin; B2 setae thickened basally, strongly tapering distally, near B3; B3 setae similar to B2 seta, between B2 and posterolateral setae; posterolateral setae curved distally; 2 pairs of midlateral setae curved distally, 1 pair longer; a campaniform sensillum laterad of D1 seta and another between B1 and B2 setae. Sternites III-VII each with an oval or elongate glandular area; on III 27–47 μm wide, 12–15 μm long; on VII 20–27 μm wide, 15 μm long.

Measurements of holotype and female paratypes: Body length 1.57 (1.55–1.75) mm distended. Other measurements in microns. Antenna: Total length 283 (269–275); length and width of segment I 24 (24), 32 (30–32); II 42 (37–40), 27 (27–30); III 52 (50–54), 22 (22–23); IV 50 (44–50), 23 (22–24); V 37 (35–37), 20 (20); VI 54 (50–52), 23 (22–24); VII 8 (7–8), 10 (10); VIII 16 (15–16), 7 (7). Length of head from anterior of eyes 100 (100–117), width at eyes 153 (141–153). Pronotum 131 (119–128) long. Forewing 943–963 (889–1007) long, 62 (62–67) wide at midlength. Abdominal tergite IX 74 (74–77) long, tergite X 74 (62–74) long. Length of setae: Ocellar setae I 15 long, setae II 12–15 long, ocellar setae III 50 (40–50) long; longest postocular setae 12–15 long; pronotal posteroangular setae outer pair 44–52 (44–54) long, inner pair 77–79 (57–86) long, median posteromarginal setae 30 (22–37) long; metanotal median setae 57 (57–67) long; B1 setae on tergite IX 99 (96–119) long, B2 setae 104 (89–111) long; B1 setae on tergite X 89 (77–91) long.

Material examined: Holotype ♀, 3 ♀ paratypes, El Segundo, California, *Lupinus chamissonis* Eschsch., 15-II-39, W. D. Pierce (USNM). Other paratypes: CALIFORNIA: Los Angeles Co., El Segundo, 4 ♀, *Encelia californica* Nutt., 15-II-39, Pierce

& Kanakoff; 1 ♂, *Rhus integrifolia* Brew. & Wats., 18-II-39, W. D. Pierce; 1 ♀, 2 ♂, compositae, 25-II-39, W. D. Pierce; 1 ♂, *Lupinus* sp., 11-III-39, Pierce & Pool; 2 ♀, *Lupinus truncatus* Nutt., 29-III-39, W. D. Pierce; 1 ♀, *Erysimum asperum* (Nutt.) DC., 31-III-39, G. P. Kanakaff; 3 ♀, 1 ♂, *Senecio californicus* DC., 15-IV-39, Pierce & Augustson; 1 ♀, 2 ♂, *Encelia californica*, 25-IV-39, J. A. Comstock. El Segundo dunes, 4 ♂, *Camissonia cheiranthifolia* (Hornem. ex Spreng.) Raimann, 30-III-88, W. Ewart; 1 ♀, *Chaenactis glabriuscula* DC., 20-III-88, W. Ewart; 3 ♀, *Lotus scoparius* (Nutt.) Greene, 30-III-88, W. Ewart; 1 ♀, *Lupinus chamissonis,* 30-III-88, W. Ewart. San Diego Co., Encinitas, 4 ♀, *Chaenactis glabriuscula,* 2-VII-35, S. F. Bailey. MEXICO: Baja California, 2 ♀, *Dudleya* sp., 22-IV-68, R. O. Parsons, at agricultural quarantine, San Ysidro (6313). Paratypes deposited in CDFA, UCD, UCR and USNM.

Distribution: Mexico (Baja California), United States (California).

Etymology: Species named after the state of California, the type locality.

Collected from: *Camissonia cheiranthifolia* (Hornem. ex Spreng.) Raimann, *Chaenactis californica* DC., *Dudleya* sp., *Encelia californica* Nutt., *Erysimum asperum* (Nutt.) DC., *Lotus scoparius* (Nutt.) Greene, *Lupinus chamissonis* Eschsch., *L. truncatus* Nutt., *Lupinus* sp., *Senecio californicus* DC., *Rhus integrifolia* Brew. & Wats.

Comments: This species is known only from southern California and adjoining Baja California. The subequal postocular setae and the chaetotaxy of abdominal tergite IX of the males differentiate *E. californicus* from its congeners.

Ewartithrips dispar, new species
(Figs. 3, 4, 8, 9, 14, 15, 17, 20, 21, 27)

Euthrips ehrhornii forma brachyptera Jones, 1912:12.

Female (macropterous and brachypterous): Body generally brown with yellow or orange-yellow internal pigments; all tarsi yellow or brownish yellow, tibiae yellow or yellowish brown, femora brown; forewings completely light brownish yellow; ocellar crescent orange-red; major setae brown or yellowish brown; antennae brown except apex of II occasionally yellowish brown, pedicel of III pale yellow and basal ⅓ yellowish brown or light brown, a light band just distal of pedicellated bases of IV–V. Brachyptera with dark brown abdomen, mesonotum a contrasting yellow.

Antenna (Fig. 8): Segments III–IV about 2.5 times longer than wide, constricted into a neck distal of subapical setae; forked trichomes on III–IV U-shaped, 30–33 μm long; inner sense cone on VI about 20 μm long.

Head (Fig. 4): Wider than long, width at cheeks distinctly wider than at eyes, cheeks progressively wider posteriorly from eyes; occiput about as long as eyes or slightly shorter, sculptured with transverse or broadly anastomosing striae. Several small anteromedial tubercles present or absent anterior of fore ocellus. Ocellar setae III between fore and hind ocelli, inside ocellar triangle. Postocular setae 5-6 pairs, usually 3rd or 4th setae longest. Mouthcone conical; mandible 185 (161–185) μm long; maxillary palps 54–57 μm long.

Pronotum: About as long as head; with transverse and anastomosing sculpture, weaker than on head and mesonotum. Discal setae short, 33–35 present; posteroangular setae about ½ as long as pronotum, outer pair shorter than inner pair; posteromarginal setae 3 pairs, occasionally total of 5. *Mesonotum*: Transversely reticulated, with 2

anteromedial campaniform sensilla. *Metanotum* (Fig. 14): Reticulated, lateral reticles longitudinally elongate, medial ones variable; median setae on anterior margin, longer than lateral setae; 0–2 campaniform sensilla present.

Forewing macropterous: Rather straight, apex pointed; 26–27 (25–27) costal setae, those on midlength longer than width of wing; 26 (22–26) anterior fringe cilia, straight or slightly wavy; fore vein with 8 setae in proximal ½, 5 (4–5, occasionally 3) in distal ½; hind vein with 11–12 (9–13) setae; scale with 5 marginal and 1 discal setae. *Brachypterous forewing*: Oval, extending to first abdominal tergite, with 7–9 marginal, 4–6 veinal setae; scale with 5 marginal, 1 discal setae.

Abdomen: Tergites IV–VII weakly sculptured anterior of median setae, VIII completely sculptured with weak reticulations; median setae about as developed as D2 setae, on tergites IV-VII slightly anterior or between median campaniform sensilla; tergite II with 3 lateral seta; posteromarginal comb on tergite VIII poorly developed (Figs. 20, 21), either complete or absent medially, microtrichia minute to about 15 μm long, sparse to 26 present, irregularly spaced; tergite IX slightly shorter than X; B1 setae on IX longer than X. Sternite I with 2–3 anteromedian setae; sternite VII with median setae far anterior of posterior margin by about 5 times its basal socket (cf. Fig. 25).

Female (micropterous): Body color and most structures similar to that of macroptera.

Antenna: Segment III strongly convex, constricted distal of subapical setae (Fig. 9); segment VII about as wide or slightly wider than long, base about as wide as apex of VI, VIII broadly conical, slightly longer than wide. *Head* (Fig. 3): Shorter than macropterous forms, similar in shape or cheeks straighter. Ocelli absent. Third postocular seta longest. *Pronotum:* With weak anastomosing sculpture; 23–25 discal setae; posteroangular setae shorter than those of macropterous form. *Metanotum* (Fig. 17): Lateral setae posterior of anterior margin, median setae in anterior ⅓ of notum, far apart. *Forewing:* Reduced to a small lobe with 4 setae. *Abdomen:* Tergites with complete anastomosing sculpture (Fig. 17); median setae well developed on II–VIII, aligned with median campaniform sensilla and D2 setae; posteromarginal microtrichia absent from VIII.

Male (micropterous): Similar to micropterous female in color and most anatomical structures.

Body length 1.28 mm, distended. *Antenna:* Length 241 μm. *Head:* 4 pairs of postocular setae, third pair longest. *Abdomen*: Tergite VIII without posteromarginal microtrichia. Tergite IX with D1 setae at about midlength, larger than B1-B2 setae (Fig. 27); B2 setae posterior of D1 setae, B1 close to each other, medially between D1 and B2 setae; B3 setae mesad or cephalad of posterolateral seta; posterolateral long; 2 midlateral setae on each side, 1 seta longer; a campaniform sensillum between B1 and B2 setae, another in anterolaterad part of tergite on each side. Sternites III–VII each with a small, glandular area, about 15 μm wide on sternite III (cf. Fig. 30).

Measurements of macropterous holotype followed by those of macropterous and brachypterous female paratypes: Body length 1.5 (1.43–1.54) mm, 1.80 mm partially distended. Other measurements in microns. Antenna: Total length 318 (308–314); length and width of segment I 32 (30–32), 32 (30–37); II 44 (42–44), 24 (27–30); III 59 (54–59), 24 (24); IV 57 (54–57), 22 (22–24); V 44 (44–47), 20 (20–22); VI 57 (54–57), 22 (21–33); VII 10 (10), 10 (10–11), VIII 15 (12–15), 8 (7–8).

Length of head from anterior of eyes 131 (124–131), width at eyes 151 (141–153), at occiput 178 (163–180). Pronotum 148 (136–148) long. Macropterous forewing length 904 (800–926), width 54 (50–54) at midlength; abdominal tergite IX 89 (79–86), tergite X 99 (94–104) long. Length of setae: Ocellar setae I about 12 long, setae II 22 (22–24) long, setae III 77 (67–86) long; longest postocular setae 59 (52–62) long; pronotal posteroangular setae outer pair 68 (52–72) long, inner pair 77 (69–82) long; median posteromarginal setae 30 (24–37) long; median setae on metanotum 50 (47–62) long; B1 setae on tergite IX 124 (104–124) long, B2 setae 138 (117–128) long; B1 setae on tergite X 117 (106–114) long.

Measurements of micropterous female paratypes significantly different from other wing forms: Body length 1.50–1.65 mm fully distended. Other measurements in microns. Antenna: Total length 263–291. Length of head from anterior of eyes 106–117, width at eyes 131–138, at occiput 136–151. Length of setae: Ocellar setae III 40–57 long; third postocular seta (longest) 42–50 long; pronotal posteroangular setae outer pair 42–54 long, inner pair 42–62 long, median posteromarginal setae 22–31 long.

Material examined: Holotype macropterous ♀, 1 macropterous ♀ paratype, Vernalis, California, alfalfa, 11-III-33, N. A. Donges (CAS). Other paratypes: CALIFORNIA: Adelanto, 3 micropterous ♀, *Phacelia* sp., 13-IV-58, W. Ewart; Ducor, 4 macropterous ♀, *Amsinckia* sp., 26-II-64, W. Ewart; Hesperia, 5 micropterous ♀, *Amsinckia* sp., 13-IV-58, W. Ewart; Hwy 466, 2 mile N. Mohave, 26 micropterous ♀, *Amsinckia* sp., 26-II-64, W. Ewart and O. L. Brawner; 2 mi N. Mohave, 2 micropterous ♀, grass, 28-III-57, W. Ewart; Porterville, 1 macropterous ♀, *Amsinckia* sp., 3-V-58, W. H. Ewart; Hwy 395 at Phelan intersection, San Bernandino Co., 1 micropterous ♀, 1 macropterous ♂, *Amsinckia* sp., 22-IV-78, W. Ewart; Hwy 6, 4 mile N. Rosamond, 7 micropterous ♀, *Amsinckia* sp., 26-II-64, W. Ewart; San Jose, 2 brachypterous ♀, wild flower, 31-III-10, P. R. Jones (USNM); Tracy, 3 macropterous ♀, alfalfa and *Amsinckia* sp., 11-III-33, N. A. Donges (UCD, USNM); North Fork Tule River near Success Dam, Tulare Co., 1 brachypterous and 1 macropterous ♀, *Amsinckia* sp., 1-II-65, O. Brawner; Hwy 91, 1 mile N. Victorville, 2 micropterous ♀, *Amsinckia* sp., 24-III-62, W. Ewart. Unless indicated, the paratypes are deposited in CDFA, BMNH, SMF, UCD, UCR, USNM. Most of the paratypes are deposited in UCR.

Distribution: United States (California).

Collected from: *Amsinckia* sp., *Medicago sativa* L., *Phacelia* sp., wild flower. True host *Amsinckia* sp.

Etymology: Specific epithet derived from Latin "dispar" (different).

Comments: Three micropterous specimens collected on *Phacelia* from Adelanto do not have ocellar setae I. However, other structures are similar to micropterous specimens collected from other hosts, and therefore are treated here as *dispar.*

Ewartithrips dispar is the most divergent of the species assigned to this genus by having a large body, occiput about same length or slightly shorter than eyes, posteromarginal comb on abdominal tergite VIII poorly developed or absent, and with three wing forms.

The two brachypterous specimens described by Jones (1912:12) as a form of *ehrhornii* are actually *dispar.* Only one additional brachypterous specimen was found in examined material from Tulare County.

This species was collected in Kern, San Bernardino, San Joaquin, Santa Clara and Tulare Counties which are located mainly in the arid central valley and desert area of California.

Ewartithrips ehrhornii (Moulton), **New Combination**
(Figs. 2, 19)

Euthrips ehrhornii Moulton, 1907:54.
Physothrips ehrhornii: Hood, 1914:39.
Taeniothrips ehrhornii: Steinweden, 1933:291; Bailey, 1957:199.
Tenothrips ehrhornii: Bhatti, 1990:203.

Female (macropterous): Body generally dark brown with slightly orange-yellow internal pigments in thorax and abdomen, or thorax more yellowish; head brown or medial part of head yellowish with vertex, submarginal and caudal parts posterior of eyes brown or yellowish brown; legs brown to femora brown with tibiae slightly yellowish brown, tarsi yellow or yellowish brown; ocellar crescent red; setae brown; forewings normally light grayish brown, occasionally pale yellow or slightly pale grayish yellow distally; antennae brown except segment I light brown, paler than head and segment II, III pale yellow in basal ½, gradually light grayish brown distally, IV pale yellow in basal ¼, V with white ring slightly distal of base.
Antenna: Segment III about 2.5 times longer than wide, margins convex; forked trichome on IV about 24 μm long, V-shaped; inner sense cone on VI 22 μm long, extending to apex of segment.
Head (Fig. 2): Slightly wider than long, width at eyes and cheeks subequal, cheeks slightly arched; occiput about ⅗ as long as eyes; ocellar setae III between fore and hind ocelli, inside ocellar triangle; normally fourth postocular setae longest, second or third setae may be longest; mouthcone conical, 124–136 μm long, apex blunt; mandible about as long as mouthcone, 117–136 μm long; maxillary palps 42–47 μm long. *Pronotum:* Slightly shorter than head, transversely sculptured; a short posteromedial line occasionally present; posteroangular setae about $\frac{3}{10}$ to about ½ as long as pronotum, outer pair usually shorter than inner pair; posteromarginal setae 3 pairs.
Metanotum: Reticulated medially, laterally with longitudinally aligned sculpturing; median setae on or near anterior margin; 0–2 campaniform sensilla present. *Forewings:* 27 (24–27) costal setae, those at midlength about as long as width of wing; 21 (23–24) anterior fringe cilia; fore vein with 5–8 (4–9) distal setae; hind vein with 13 (11–12) setae; scale with 5 marginal and 1 discal setae. *Abdomen:* Median setae on anterior and intermediate tergites anterior of median campaniform sensilla, reduced, larger posteriorly; tergites IV-VIII without sculpturing between median setae; posteromarginal comb on tergite VIII complete with 39 (31) close-set microtrichia up to 24 μm long (Fig. 19); sternite I with 1–3 anteromedian setae; B1 setae anterior of posterior margin by about 5 times their bases (cf. Fig. 25).
Male (macropterous): Similar in most anatomical structures to that of female. Body brown with orange-red internal pigments, head yellowish between eyes to vertex; ocellar crescent red; tarsi yellowish brown, tibiae and femora brown to yellowish brown; forewings light brown; setae brown; antenna brown except segment I yellowish brown, lighter than II, III with pedicel and extreme base pale white.

Body length 0.85–1.02 mm, 1.02–1.27 mm distended. *Antenna:* Length 252–270 µm. *Head:* The 3rd or 4th postocular seta longest; mouthcone 94–104 µm long, broadly conical, mandible about same length as mouthcone, 86–100 µm long, maxillary palps about 37 µm long. *Abdomen:* Tergite VIII with well developed posteromarginal comb; tergite IX with setal arrangement similar to those of *flavidus* (cf. Fig. 28). Glandular areas on sternites III–VI, on VI almost circular to slightly oval, varying from 7 µm wide, 7 µm long to 15 µm wide, 12 µm long (cf. Fig. 31).

Measurements of lectotype and other females: Body length 1.21 (partially distended) (1.18 slightly distended to 1.45 fully distended) mm. Other measurements in microns. Antenna 271 (240–298) long. Forewings: 865–869 (754–808) long, 57 wide at midlength. Setal lengths: Ocellar setae III (37–62) long; pronotal posteroangular setae outer pair 52–57 (47–57) long, inner pair 68–71 (54–62) long; metanotal median setae 47–50 long; B1 setae on abdominal tergite IX 96 (94–104) long, B2 setae 111 (101–111) long; B1 setae on tergite X 86 (89) long.

Material examined: Lectotype ♀, 1 paralectotype ♀, Alum Rock Canyon, San Jose, California, grass, 29-V-06, D. Moulton (CAS). Lectotype designated by S. Nakahara. Other material: Alum Rock Park, 2 ♀, grass, 26-IV-49, S. F. Bailey (UCD). Hamet, 1 ♀, *Lotus* sp., 30-IV-58, Ewart and Brawner (UCR); 4 ♂, Chamise, 7 and 20-VII-60, W. Ewart and O. Brawner (UCR); Lompoc, 1 ♀, *Atriplex* sp., 12-V-65, Bets et al. (USNM). Oceano, 1 ♀, sweeping 24-IV-51, S. F. Bailey (UCD). Trinidad, 1 ♀, *Ceanothus* sp., 13-V-30, D. Moulton (CAS); 1 ♀, *Baccharis pilularis* DC., 25-IV-63, T. R. Haig (USNM). Woodside, 1 ♀, *Lupinus* sp., 22-V-26, D. Moulton (CAS).

Distribution: United States (California).

Collected from: *Atriplex* sp., *Baccharis pilularis* DC., *Ceanothus* sp., grass, *Lotus* sp., *Lupinus* sp.

Comments: Bailey's (1957:199) comments about this species being difficult to distinguish from *longirostrum* hold true. The mouthcones of *longirostrum* (from dorsal-ventral view) females are 148–165 µm long, narrowed and elongate conical or subcylindrical distally. The mandibles are about same length as the mouthcone. In contrast mouthcones of *ehrhornii* based on identified material are 124–136 µm long, and are more broadly conical distally. The mandible is also shorter than those of *longirostrum.* However, these characters can be difficult to use because of distortions. The maxillary palps of *ehrhornii* are slightly shorter than those of *longirostrum.* The forewings of the females are slightly longer (754–869 µm) in *ehrhornii* than *longirostrum* (660–753 µm) but this difference is based on few forewings. The short median line on the pronotum of *longirostrum* mentioned by Bailey (1957:199) is occasionally found on *ehrhornii.*

According to Moulton's (1907:55) description, the forewings are uniform light gray-brown. The more recently collected material determined as *ehrhornii* has grayish brown forewings. However, old material and a specimen collected in 1958 have pale yellow forewings with light grayish shade distally. This difference in coloration could be attributed to the macerating technique or age of the slides. Because most specimens available for study are old, new material is needed to resolve problems of forewing color as well as the shape and length of the mouthcone.

The description of the male is based on four identified specimens from Hamet, California. The male described by Jones (1912:12) as *ehrhornii* is treated here as *longirostrum.* In the USNM collection is a single male on a slide labeled *Euthrips*

ehhornii [sic] Moulton, ♂, Type, on *Collinsia bicolor* Benth, Los Gatos, Cal., 4/9/10, P. R. Jones Coll. The collection data are the same as that of the holotype of *longirostrum.*

Bailey (1957:199) treated *Euthrips ehrhornii* forma brachyptera of Jones (1912: 12) as a synonym of *ehrhornii.* In the USNM are two specimens with the same collection data given by Jones and labeled as forma brachyptera. They are here treated as a new species, *dispar.*

Ewartithrips flavidus, new species
(Figs. 6, 10, 11, 13, 22, 25, 28, 30)

Female (macropterous): Body yellow or golden yellow with thorax darker golden or orange-yellow; abdomen with tergite I shaded light grayish brown, normally anterior and intermediate tergites light grayish brown in anterior area and median area to posterior margin or just confined to anterior areas, posterior tergites usually completely yellow except apex of X grayish brown, antecostal ridges on III–VII darker grayish brown, or concolorus with tergal derm; legs yellow; ocellar crescent orange-red; major setae brown; forewings pale grayish yellow to light grayish brown, may be paler between dorsal veins. Antennae brown except segment I whitish yellow or light grayish yellow, II brown with base pale yellow, basal ½ of III light yellow, basal ¼ of IV light yellow, V with whitish yellow band distal of pedicel (Fig. 10).
Antenna (Fig. 10): Segment III 2.2–2.5 times longer than wide, constricted distal of subapical setae; forked trichome on III and IV V-shaped, 22–27 μm long on IV; inner sense cone on VI extends slightly beyond apex of segment, 20–24 μm long.
Head (Fig. 6): Wider than long, margin of vertex somewhat rounded between eyes, cheeks slightly arched, occiput with transverse and anastomosing sculpture. Eyes longer than occiput, interocular distance about 1.5 times wider than width of eye. Anteromedial tubercle absent. Fore ocellus 15 (12–15) μm wide; hind ocelli separated by about twice diameter of fore ocellus. Ocellar setae III between fore and hind ocelli, inside or on border of ocellar triangle, separated by 1.5 to 1.8 times diameter of fore ocellus. Postocular setae 5–6 pairs, normally 4th pair longest, occasionally 3rd pair longest, other setae ½ to ⅔ as long as longest setae. Minute pores, 2–4 between postocular setae i and hind ocelli. Mouthcone conical; mandible 119 (106–131) μm long; maxillary palps 54 (42–44) μm long.
Pronotum (Fig. 11): About as long as head, with transverse or anastomosing sculpture. Discal setae 36 (34–39) present, short, 1 pair anterior to posteromarginal setae thicker and longer than others; posteroangular setae $\frac{3}{10}$ to ½ as long as notum; posteromarginal setae 3 pairs, median pair longest. *Mesonotum:* Completely sculptured with anastomosing striae; 2 anteromedian campaniform sensilla; submedian setae short, almost aligned with lateral setae. *Metanotum* (Fig. 13): Median ⅓ reticulated, reticles irregular, rather broad, laterally with longitudinal sculpture; median setae on or near anterior margin; 0–2 campaniform sensilla normally in midlength or farther caudally.
Forewing: Straight, pointed at apex; 22–23 (22–26) costal setae, those at midlength about as long as or slightly shorter than width of wing; 21–22 (23–24) wavy anterior fringe cilia; fore vein with 7 or 8 setae in basal ½, 5 or 6 setae in distal ½; hind vein with 12 (9–13) setae; scale with 5 marginal and 1 discal setae.

Abdomen: Median setae short on anterior tergites, longer caudally, on tergite VIII 24–32 μm long. Median campaniform sensilla progressively closer to posterior margin caudally, on tergite VIII about 1.5 times its diameter cephalad of posterior margin. Sculpture lines absent medially from tergites IV-VIII, extending slightly mesad of D2 setae; submarginal sculpture lines with indistinct microtricha. Posterior margins of VI and VII with low, broad, lobes (Fig. 22). Posteromarginal comb on VIII complete with 33–37 close-set microtrichia, longest 17–22 μm long. Tergite IX longer than tergite X. Sternite I with 2–3 anteromedian setae. B1 setae on sternite VII anterior of posterior margin by 6–7 times their setal base, closer to B2 setae (Fig. 25).

Male (macropterous): Similar to female in color and most morphological structures, but smaller.

Body length 1.15–1.35 mm (distended). *Antenna:* Length 263-278 μm. *Abdomen:* Tergite VIII with complete posteromarginal comb. Tergite IX (Fig. 28) with D1 setae in about midlength of tergite, thick; B1 setae thin, medially between D1 setae or slightly posterior; B2 setae thin, farther posterior and wider apart than D1 setae; posterolateral setae thick, long; a shorter seta anteromesad or mesad of posterolateral setae; midlateral setae 2 on each side, 1 longer and thicker than other; pair of campaniform sensilla posterior of D1 setae, another pair anterolaterad of D1 setae. Sternites III–VII each with oval or circular glandular area (Fig. 30), on III and VII 20–30 μm wide, 12–15 μm long; when circular about 12 μm in diameter.

Measurements of holotype and female paratypes: Body length 1.41 (1.24–1.55) mm distended. Other measurements in microns. Antenna: Total length 283 (242–281); length and width of segment I 24 (24), 27 (25–30); II 40 (37–42), 25 (23–25); III 52 (44–52), 21 (20–21); IV 52 (42–52), 20 (18–22); V 40 (32–40), 18 (17–18); VI 50 (44–52), 21 (20); VII 10 (7–10), 10 (8–10); VIII 15 (12–15), 7 (7). Length of head from anterior of eyes 119 (114–131), width at eyes 136 (124–141); pronotum 119 (106–128) long. Forewing 719–746 (650–776) long, 50 (42–50) wide at midlength. Abdominal tergite IX (62–74) long, tergite X (62–64) long. Length of setae: Ocellar setae I about 12 long, setae II about 12 long, setae III 54 (42–54) long; postocular setae iii or iv longest, 27 (22–35) long; pronotal posteroangular setae outer pair 44–47 (27–54) long, inner pair 54–57 (35–59) long, median posteromarginal setae 22–27 (20–27) long; metanotal median setae 52 (42–57) long; median setae on abdominal tergite VIII 24–32 long; B1 setae on tergite IX 109–114 (72–117) long, B2 setae 124 (77–124) long, B3 setae 91 (69–114) long; B1 setae on tergite X 100 (77–100) long, B2 setae 96 (69–96) long.

Material examined: Holotype ♀, 22 ♀ and 14 ♂ paratypes, Murrieta, Riverside Co., California, *Lonicera* sp., 26-II-67, R. J. Gill (USNM). Paratypes. CALIFORNIA: Hwy 128, 13.9 miles W. of Winters, Yolo Co., 54 ♀♀ and 6 ♂, *Adenostoma fasciculatum* Hook. and Arn., 16-IV-66, T. and C. S. Kono; 3 ♀, *Arctostaphylos* sp., 26-III-66, T. and C. S. Kono; 25 ♀, *Cercocarpus betuloides* Nutt., 26-III-66, T. Kono and C. S. Kono. Paratypes deposited in CAS, CDFA, CNC, FSCA, BMNH, SMF, UCD, UNAM, USNM.

Other material examined: CALIFORNIA: Riverside Co., 1 ♂, wild apricot, 16-III-66, W. H. Ewart and O. Brawner (UCR). Green Valley, Solano Co., 1 ♀, chamiso, 29-III-49, S. F. Bailey (UCD). Near Grizzly Springs Lake, Colusa Highway, 1 ♀, grass, 14-V-47, S. F. Bailey (UCD). Mix Canyon, Solano Co., 1 ♀, ceanothus flow-

ers, 6-III-36, S. F. Bailey (UCD); 1 ♀, ceanothus flowers, 6-III-36, S. F. Bailey (UCD); 1 ♀, California laurel, 1-II-39, S. F. Bailey (UCD); 2 ♀♀, laurel flowers, 17-II-39, S. F. Bailey (UCD). Mt. Diablo, Contra Costa Co., 1 ♀, beating, 29-V-51, S. F. Bailey (UCD). Palo Alto, Page Mill Road, Santa Clara Co., 1 ♀, beating manzanita, 27-IV-49, S. F. Bailey (UCD). Near Rumsey, Yolo Co., 1 ♀, ceanothus flowers, 12-IV-49, H. E. Cott (UCD). Zaca Mt., Santa Barbara Co., 1 ♀, chamiso, 1 ♀, beating, 24-IV-51, S. F. Bailey (UCD); Woodside, San Mateo Co., 1 ♀, 1 ♂, honeysuckle, 22-V-26, D. Moulton (CAS).

Distribution: United States (California).

Collected from: *Adenostoma fasciculatum* Hook. and Arn. (=chemiso), *Arctostaphylos* sp. (=manzanita), *Ceanothus* sp., *Cercocarpus betuloides* Nutt. (=*betuloides* Sarg.), grass, *Lonicera* sp. (=honeysuckle), *Prunus armeniaca* L., (=apricot), *Umbellularia californica* (Hook. and Arn.) Nutt. (=California laurel).

Etymology: Specific epithet derived from Latin "flavidus" (yellowish), which describes the color of the body.

Comments: The yellowish body separates this species from its congeners. According to Bailey (1957), the body of typical *ehrhornii* has a pronounced orange-yellow color. However, the *ehrhornii* types are predominantly brown with completely brown abdomens. None of the *flavidus* populations examined in this study with a long series of pronounced orange-yellow or yellow specimens had any mixture of predominantly brown specimens with completely brown abdomen, although most specimens have pale grayish brown shading on abdominal tergites and metanotum. If my identifications of *ehrhornii* males are correct, the males are brown and have glandular area on abdominal sternites III-VI. Males of *flavidus* are yellow and have glandular area on abdominal sternites III-VII.

Ewartithrips longirostrum (Jones), **New Combination**
(Figs. 7, 31)

Euthrips longirostrum Jones 1912:12.
Physothrips longirostrum: Hood 1914:39.
Mycterothrips longirostrum: Karny 1921:216.
Taeniothrips longirostrum: Steinweden 1933:291.

Female (macropterous): Body generally brown with orange-yellow internal pigments; head often lighter yellowish brown around eyes and vertex; legs with all tarsi yellow, tibiae yellowish brown with margin light brown or mainly yellow, femora yellowish brown or predominantly light brown; forewings pale yellow; ocellar crescent orange-red; major setae brown; antennae brown except segment I light brown, paler yellowish brown in basal $\frac{1}{3}$ of III and in basal $\frac{1}{4}$ of IV, and V with a short pale band just distally of pedicel.

Antenna: Segment III 2.1–2.3 times wider than long; forked trichome on IV V--shaped, 20–24 μm long. *Head* (Fig. 7): Wider than long, width at eyes and cheeks subequal, cheeks slightly arched, occiput about $\frac{3}{5}$ as long as eye; ocellar setae III between fore and hind ocelli, inside ocellar triangle. Postocular setae iii or iv longest. Mouthcone from dorsal-ventral view elongate conical, extending into mesosternum, 148–165 μm long; prementum plus paraglossa 1.5 to more than twice as long as prementum width, occasionally subcylindrical; mandible about as long as mouth-

cone; maxillary palps 52–57 μm long. *Pronotum*: Slightly longer than head, transversely sculptured with anastomosing reticulations, with a short, posteromedial line; posteroangular setae ⅓–⅖ as long as pronotum, outer pair usually shorter than inner pair; 3 pairs of posteromarginal setae. *Metanotum*: Reticulated, lateral reticles more elongate longitudinally and narrower than medial reticles; median setae on anterior margin; 0–2 campaniform sensilla present. *Forewing*: 21–26 costal setae, those at midlength about as long or longer than width of wing; 17–21 straight anterior fringe cilia; fore vein with 5–6 distal setae, 6–8 setae in proximal ½. *Abdomen*: Tergites III–VIII without median sculpturing; posteromarginal comb on tergite VIII complete with 29–38 close-set microtrichia, mostly 20–24 μm long (cf. Fig. 19); sternite I with 2–3 anteromedial setae, B1 setae on sternite VII far anterior of posterior margin (cf. Fig. 25).

Male (macropterous): Similar to females in color and most morphological characters, but smaller. Antennal segment I pale yellowish brown or more yellowish, lighter than II; II yellowish brown to light brown; III pale yellow in basal ½, light grayish brown distally; basal ⅓ of IV light yellow, light brown distally; V pale yellow in basal ¼, brown distally; VI–VIII brown.

Body length 0.98 mm. *Antenna:* Length 251 μm. *Head:* Mouthcone about 131 μm long, elongate conical, extending posteriorly between procoxae; mandibles about same length as mouthcone; maxillary palps 47–57 μm long. *Abdomen*: Tergite VIII with complete, well-developed posteromarginal comb. Tergite IX with setae bristle-like (cf. Fig. 28); B1 setae between but slightly posterior of thicker and longer D1 setae; B2 setae similar to B1 setae, posterolaterad of D1 setae; B3 setae mesad of posterolateral setae; posterolateral setae largest; 2 midlateral setae on each side, 1 longer; a pair of campaniform sensilla posterior of D1-B1 setae, another pair anterolaterad of D1 setae towards anterior margin. Abdominal sternites III–VI (Fig. 31) each with a small, oval glandular area, about 5 μm long, 7 μm wide on sternite VI.

Measurements of females: Measurements based on types and identified material: Body length 1.02 to 1.17 mm (partially compacted), 1.43 mm (fully distended). Other measurements in microns. Antenna 235–259 long. Forewing 660-753 long. Length of setae: Ocellar setae III 37–54 long; longest postocular setae 15–22 long; pronotal posteroangular setae outer pair 42–50 long, inner pair 44–50 long; metanotal median setae 42–54 long. B1 setae on abdominal tergite IX 74–119 long, B2 setae 99–136 long; B1 setae on tergite X 79–99 long.

Material examined: *Euthrips longirostrum* Jones, Holotype ♀, 2 paratype ♀, Los Gatos, California, flowers of perennial lupine, 16-IV-10, P. R. Jones (USNM). Other material: CALIFORNIA: El Segundo, 3 ♀, 1 ♂, *Lupinus chamissonis* Eschsch., 15-II-39, W. D. Pierce; Figuerora Mt., 1 ♀, manzanita or lupine, 24-IV-51, S. F. Bailey (UCD); Los Gatos, 1 ♂ (labeled *Euthrips ehhornii* [sic] Moulton Type) *Collinsia bicolor* Benth., 9-IV-10. P. R. Jones; 1 ♀, blue legume, 16-IV-10, P. R. Jones; San Jose, 1 ♀, blue lupine, 13-IV-11, P. R. Jones; 8 ♀, 2 ♂, lupine, 17-IV-11, P. R. Jones. The examined specimens are deposited in the USNM except where otherwise indicated.

Distribution: United States (California).

Collected from: *Collinsia bicolor* Benth., blue legume, *Lupinus chamissonis* Eschsch., *Lupinus* sp.

Comments: The differences between *longirostrum* and *ehrhornii* are discussed in

the comments for *ehrhornii.* Jones (1912:12) described *longirostrum* based on four females. The collection data of the types consisting of a slide labeled holotype and 2 slides labeled paratypes in the USNM have the same collection locality, Los Gatos, but different collection dates than May, 1910 given in Jones' (1912:12) original description. The date for the holotype is April 9, 1910 and those of the paratypes are April 16, 1910. Furthermore, the host of the types is stated to be "flowers of perennial lupine" but a label on the back of the collection label of the holotype gives the host as *Collinsia bicolor,* which is crossed out. On the back of the type labels written in red ink, presumably by Jones, is "Euthrips longirostrum Jones, ♀, Type." The Jones' specimens were previously deposited in J. D. Hood's collection which is now part of the USNM collection. The holotype and paratype labels are those of Hood. Despite the discrepancies of the collection data, I am accepting the three specimens as types based primarily on the type designated by Jones. The location of the fourth type specimen is unknown to me.

A slide labeled "*Euthrips ehhornii* [sic] Moulton, ♂, Type" in red ink has the same original collection data as that of the holotype of *longirostrum* Although the mouthcone of the male is distorted and the shape cannot be ascertained, I consider this male to be a *longirostrum,* not a paratype. Jones did not mention any males in his description.

The examined material was collected in the coastal counties of California and in about the same time of the year as *ehrhornii.* This species apparently prefers lupines, *Lupinus* sp.

Ewartithrips salviae, new species
(Figs. 5, 12, 18, 23, 29)

Female (macropterous): Body brown with reddish orange internal pigment. Tarsi yellow; foretibiae yellowish brown to completely yellow; mid- and hindtibiae brown with apex yellow, base yellow or brown; femora brown. Ocellar crescent red. Setae brown. Forewing uniformly light yellowish white. Antennae: Segment I brown; II basally brown, distally yellowish brown or yellow; III yellow, extreme apex grayish brown or completely yellow; IV yellow, light brown distal of subapical setae or completely yellow; V yellow, brown in distal ⅓; VI yellow in basal ⅓ to ⅖, brown distally; VII–VIII brown.

Antenna: Segment III slightly constricted distally of subapical setae, 2.3 times longer than wide; III and IV each with a forked trichome, 17–20 μm long on IV; inner sense cone on distal ⅓ of VI, 20–22 μm long, extending distally to apex of segment.

Head (Fig. 5): Broader than long, cheeks rather straight, occiput sculptured with transverse, widely separated striae or broad reticles, often a transverse line more strongly defined midway between eye and posterior margin. An anteromedial tubercle present or absent. Fore ocellus 12 μm wide. Ocellar setae III long, between fore and hind ocelli on border of ocellar triangle, separated by 22 (20) μm. Postocular setae 5 or 6, seta iii longest, occasionally postocular seta iv longest. Mouthcone conical to elongate conical, 119 (124–148) μm long; mandible 104 (121–138) μm long, maxillary palps 54 (50) μm long.

Pronotum: Longer than head, with anastomosing sculpture. Discal setae 32 (33–38) present, normally shorter than median posteromarginal setae. Posteroangular setae $\frac{3}{10}$ to

½ as long as pronotum. Posteromarginal setae 3 pairs, occasionally 2 pairs. *Mesonotum* (Fig. 12): Completely sculptured with anastomosing striae; pair of anteromedian campaniform sensilla present. *Metanotum:* Median ½ with broad reticles, laterally with longitudinal sculpture; median setae far apart; pair of campaniform sensilla slightly posterior of midlength; a pair of minute median pores in anterior ⅓.
Forewing: Pointed at apex; 21–23 (17–24) costal setae; 19 (16–19) anterior fringe cilia; fore vein with 7 setae in basal ½, 3–4 setae in distal ½; hind vein with 8–9 (7–10) setae; scale with 5 marginal and 1 discal setae.
Abdomen: Tergites completely sculptured, those on posterior tergites polygonal medially and weaker than on anterior tergites with more transverse striae (Fig. 18). Median setae short and thinner than D2 setae, progressively longer posteriorly, longest on VIII, far apart, slightly anterior of median campaniform sensilla, sensilla progressively closer to posterior margin caudally. Posteromarginal comb on tergite VIII complete with 38 (33–36) microtrichia, 15–20 μm long (cf. Fig. 19). Tergite IX longer than tergite X. Sternite I with 2–3 anteromedian setae (Fig. 23); median pair of setae on VII closer to B2 setae than each other, anterior of posterior margin by 4–5 times their setal bases.
Male (macropterous): Similar to female in color and most morphological structures, but smaller.
Body length 1.29 mm distended. *Antenna*: Length 248 μm. *Abdomen*: Tergite VIII with complete comb. Tergite IX with D1 setae on about midlength (Fig. 29), thick and long; B1 setae between and slightly posterior of D1 setae, on tuberculate bases; B2 setae posterolaterad of D1 setae; posterolateral setae thick, long; B3 setae anteromesad of posterolateral seta; two midlateral setae on each side, 1 longer; pair of campaniform sensilla posterolaterad of B1 setae, another pair anterolaterad of D1 setae. Sternites III–VI with small, transversely oval or elongate glandular area; on III 30 μm wide, 10 μm long; on VI 17 μm wide, 7 μm long.
Measurements of holotype and female paratypes: Body length from interantennal process 1.45 (1.24–1.47) mm distended. Other measurements in microns. Antenna: Total length 265 (253–270); length and width of segment I 24 (24–27), 28 (27–30); II 40 (37–40), 27 (27); III 47 (44–47), 20 (20–21); IV 44 (42–44), 20 (20); V 35 (32–37), 20 (20–21); VI 50 (47–50), 20 (20–22); VII 10 (9–10), 9 (9–10); VIII 15 (15), 7 (6–7). Length of head from anterior of eye 106 (100–112); width at eyes 136 (131–143). Pronotum 133 (131–138) long. Forewings 697–699 (711–724) long, 50 wide at midlength. Length of setae: Ocellar setae I 7–12 long, setae II 12 long, setae III 37 (50–62) long; longest postocular setae 40–42 long; pronotal posteroangular setae outer pair 40–47 (32–57) long, inner pair 47 (40–74) long, median posteromarginal setae 22 (20–37) long; median metanotal setae 52–69 long; median setae on abdominal tergite VIII 20–24 long; B1 setae on tergite IX 111 (101–128) long, B2 setae 131 (128–148) long, B3 setae 136 (128–143) long; B1 setae on tergite X 100 (94–117) long, B2 setae 100 (94–109) long.
Material examined: Holotype ♀, 3 ♀ paratypes, Millar Canyon, N. of Cabazon, Riverside Co., California, 2,800′ elevation, galls on *Salvia* sp., 18-IV-68, E. Schlinger (68–124) (CAS). Paratypes: CALIFORNIA: Cajon Pass, San Bernardino Co., 1 ♀, *Salvia vayseyi* (T. Porter) Parish, 28-V-59, W. Ewart and O. Brawner (UCR 59-118); Hamet, Riverside Co., 2 ♀, 1 ♂, *Salvia apiana* Jeps., 27-V-83, W. Ewart (UCR 83-63). Paratypes deposited in UCR and USNM.

Distribution: United States (California).
Collected from: *Salvia apiana* Jeps., *S. vayseyi* (T. Porter) Parish.
Etymology: Named after the generic name of host, *Salvia.*
Comments: This species can be distinguished from its congeners by the coloration of the antennae and completely sculptured abdominal tergites.

The forewings of the single male are curled and cannot be measured accurately.

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REVISION OF *GANSIA* SHARP OF MÉXICO AND CENTRAL AMERICA (COLEOPTERA: STAPHYLINIDAE; ALEOCHARINAE)[1]

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Abstract.—Mexican and Central American species of the staphylinid genus *Gansia* are revised, and descriptions, keys and illustrations are provided for their identification. Lectotypes and paralectotypes are designated for the previously described species *G. bicolor* Sharp, 1883 and *G. tibialis* Sharp, 1883. The following species are described as new: *Gansia andersoni* Ashe and Lingafelter (type locality: México, Chiapas, Volcán Tacaná, 4 km N Union Juarez); *Gansia bipictanota* Ashe and Lingafelter (type locality: Panamá, Chiriquí Prov., 20.4 km N San Felix); *Gansia flavata* Ashe and Lingafelter (type locality: México, Guerrero, 63.2 km NE Atoyac de Alvarez); *Gansia fortemaculata* Ashe and Lingafelter (type locality: Honduras, Olancho Prov., La Muralla, 14 km N La Union); *Gansia obscura* Ashe and Lingafelter (type locality: Costa Rica: Guanacaste Prov., Cacao Biol. Sta.); *Gansia tachynota* Ashe and Lingafelter (type locality: Panamá, Chiriquí Prov., 20.4 km N San Felix); *Gansia taeniata* Ashe and Lingafelter (type locality: Panamá, Panamá Prov., 6.9 km S. Gamboa, Old Plantation Rd.); *Gansia tergopunctata* Ashe and Lingafelter (type locality: Panamá, Chiriquí Prov., La Fortuna, "Cont. Div. Trail"); *Gansia unizonata* Ashe and Lingafelter (type locality: Panamá, Chiriquí Prov., 20.4 km N San Felix). Evidence is provided that members of *Gansia* primarily occur in the rotting and fermenting leaves of treefalls and similar habitats where they feed on fungal hyphae and molds.

Members of the neotropical genus *Gansia* are among the most distinctive and striking of the smaller Aleocharinae. Sharp (1883:282) described them as "among the most elegant of the Staphylinidae." Their slender, falagrioid form, with very long, slender legs and antennae, their dramatic and contrasting color patterns, and their distinctive antennae with white or yellowish apical articles (see Figs. 1, 11–18, and description below) make them among the most easily recognized of the neotropical aleocharines.

Sharp (1883) first described the genus *Gansia* based on two species, *G. bicolor* and *G. tibialis* from Guatemala. In addition, Sharp also pointed out that *Falagria varicornis* Sharp that he had previously described from the Amazon region of South America (1876) should also be assigned to this genus. Later, Fenyes (1918) designated the type species to be *G. bicolor* Sharp. Since then the genus has received very little attention. Bernhauer (1921) described one additional species, *G. antennaria* from Bolivia, bringing the total described species in the genus to four.

Sharp (1883) originally classified *Gansia* as a member of the "Group Bolitocharina" because of their 4, 4, 5 tarsal formula, but he pointed out that members of the

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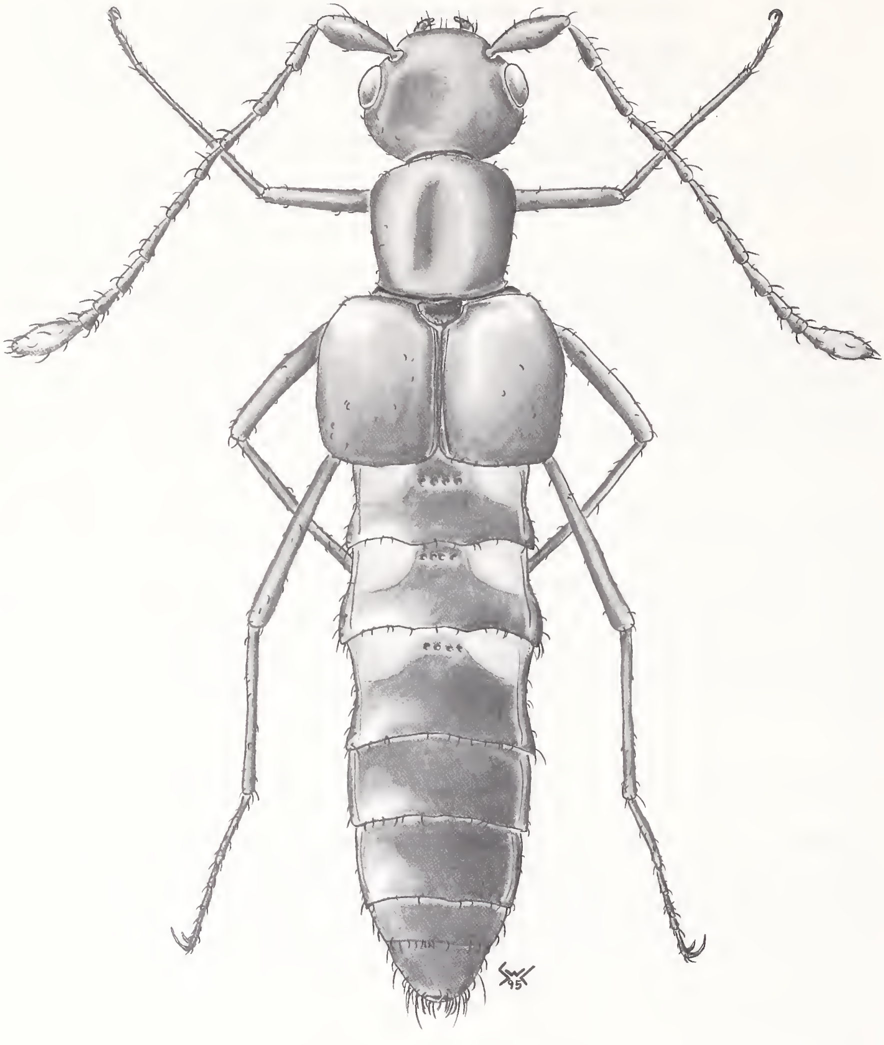


Fig. 1. *Gansia fortemaculata* n. sp., dorsal habitus.

genus were quite isolated within the bolitocharines and noted that they were similar to members of the genera *Autalia* and *Euvira.* Subsequently, Fenyes (1918) placed the genus in his "Group Autaliae" of the tribe Bolitocharini (more correctly called the tribe Homalotini, see Newton and Thayer, 1992) in which he placed the three previous genera as well as *Eudera.* This placement was followed by Bernhauer and Scheerpeltz (1926) and Blackwelder (1944) who added additional genera to the group. Ashe (1991) removed *Euvira* from the Autaliina and placed it in a separate tribe with *Placusa,* and Ashe and Leschen (1995) noted that several of the remaining genera in the Autaliina, including *Gansia,* probably form a monophyletic group.

However, this latter proposition requires confirmation by rigorous phylogenetic analysis.

Recent collecting has shown that the members of *Gansia* are abundant in some habitats in Central and South America, and that the genus is represented by numerous undescribed species throughout tropical America. In this paper we revise the species of México and Central America. Herein we redescribe *G. bicolor* and *G. tibialis* and designate lectotypes for each, describe nine new species, discuss the distribution, habitats and feeding habits of members of *Gansia,* and provide keys and illustrations for identification of the species of México and Central America. In addition to the species treated here we have examined at least 20 undescribed species of *Gansia* from South America. However, most of the South American taxa are represented by very few specimens and we have elected to revise these in a separate paper when more material is available.

MATERIALS AND METHODS

We found that few museums have identified specimens of *Gansia* in their collections. The following museums and curators contributed specimens used in this revision. The four letter acronym indicates the designation used for that museum in the descriptive sections.

American Museum of Natural History, New York (Lee Herman) (AMNH)
Instituto Nacional de Biodiversidad Collection, Costa Rica (Angel Solis) (INBI)
Field Museum of Natural History, Chicago (Alfred F. Newton, Jr.) (FMNH)
Natural History Museum, London (Emma de Boise) (BMNH)
Snow Entomological Museum, University of Kansas, Lawrence (KSEM)

Throughout this revision we have referred to the abdominal segments by their morphologically comparable names (as in Blackwelder, 1936). Thus the first fully visible segment is segment III, the second fully visible is segment IV, and so forth. Note that tergum II is narrowly visible under the edge of the elytra in most *Gansia* specimens.

We examined the mouthparts of *G. bicolor, G. fortemaculata, G. andersoni, G. flavata* and 2 undescribed species of *Gansia* from South America on microscope slides. No significant variation in characters described for the genus *Gansia* were noted. Only mouthparts of *G. fortemaculata* are illustrated, and these are consistent with those of *G. bicolor* (the type species of *Gansia*).

A few collection localities for several species could not be located and are not shown on the distribution maps.

Gansia Sharp, 1883

Diagnosis: Members of *Gansia* can be easily recognized by the combination of: 4-4-5 tarsal formula; distinctive slender body form (Figs. 1, 11–18) with head, pronotum and abdomen narrower than elytra; contrasting color patten (Figs. 1, 11–18); head with distinct neck; very long and slender antenna with apical segment white or pale yellow; long and slender legs; pronotum longitudinally impressed medially; mesosternum with apical margin recurved to form a distinct "neck"; mesocoxae moderately broadly separated; mesosternal process extended 0.4–0.5 times length of

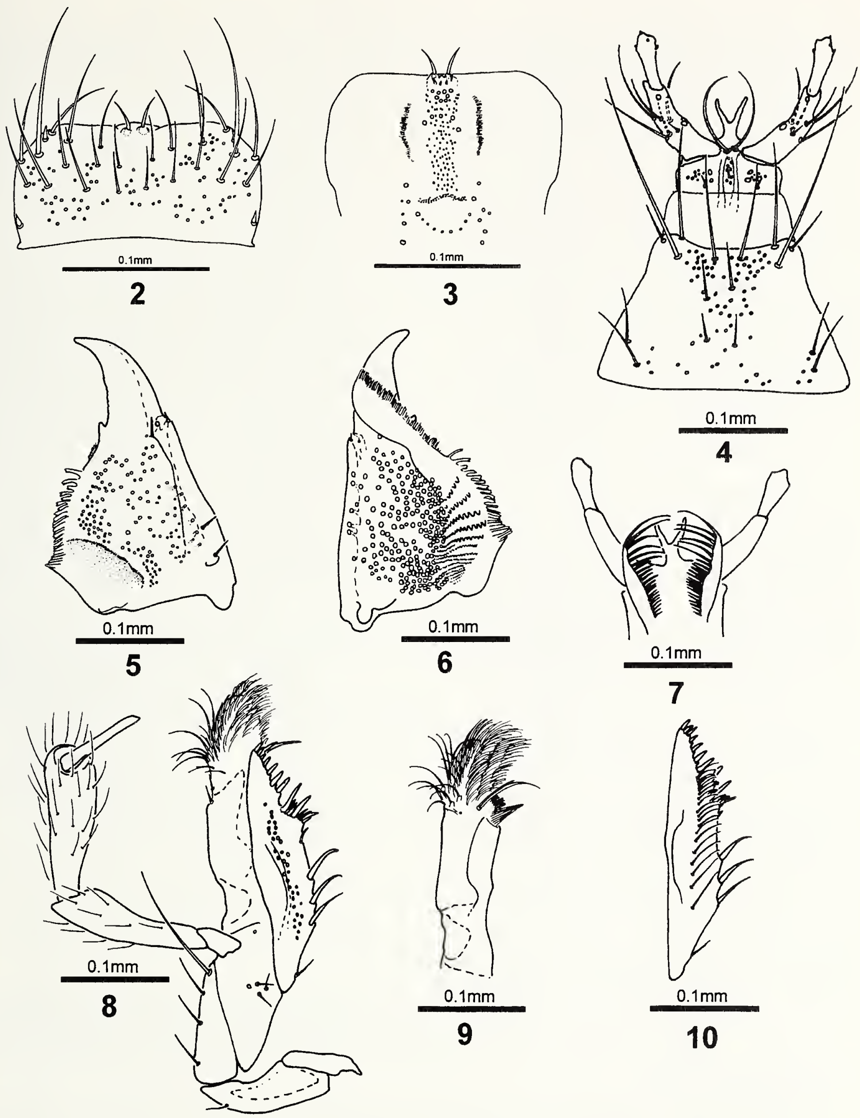
coxae and overlapping metasternal process, isthmus absent; and, deep transverse impressions on terga and sterna of abdominal segments III–V with moderate to large punctures.

Description: Length of adults 2.3–3.5 mm. Body elongate, slender, with very elongate legs and antennae; pronotum and head narrower than elytra and base of pronotum much narrower than base of elytra; base of abdomen narrower than apex of elytra (Figs. 1, 11–18). Body color varied, most distinctly bicolored, with light flavate or rufo-flavate markings contrasting with reddish-brown, piceus or black ground color, or with blackish markings contrasting with flavate or rufo-flavate ground color (Figs. 1, 11–18); apical article of antenna white or pale yellow. Microsculpture faint to absent, integument shining. Microsetae very sparse and short; macrosetae moderate-sized to prominent on abdomen, absent from remainder of body.

Head: More or less oval, narrowed behind the eyes to form conspicuous neck 0.5–0.6 times width of head. Eyes moderate-sized, length of eyes about equal to, or slightly shorter than, length of temples. Dorsal surface of head evenly rounded (in most) (Figs. 11, 13) or broadly depressed medially (in some) (Figs. 1, 12). Infraorbital carina complete but faint, absent anteriorly, or totally absent. Microsculpture absent, integument shiny; microsetae very short and sparse; punctures very small and inconspicuous to moderate in size. Antennae very elongate and slender, articles decreasing in length from 1 to 10; articles 1–8 or 1–9 very elongate; articles 9–10 or 10 slightly elongate to subquadrate; article 11 elongate and connate, as long or longer than 9–10 together, color white to pale yellow (Fig. 1).

Mouthparts: Labrum (Fig. 2) transverse, slightly lobed medially, a-sensilla absent; epipharyngeal area (Fig. 3) with patch of large pores anteriorly in medial area, a medial longitudinal field of numerous minute pores, an irregular transverse, double row of minute pores near posterior border, a semicircular row of 8–10 larger pores behind this double row of minute pores and field of 5–6 large pores on each side lateral to these. Mandibles (Figs. 5, 6) with ventral molar patch of denticles present, in more or less distinct transverse rows; both mandibles with numerous, large and closely arranged sensory pores, especially on ventral side; right mandible with small medial tooth, absent from left mandible. Maxilla (Figs. 8, 9, 10) with lacinia with apical row of about 6 more or less distant teeth, a small lobe below these with numerous large and small spines, and 3–4 large apically curved spines more basally; ventral surface of lacinia with longitudinal row of large sensory pores (Fig. 8); dorsal surface or lacinia (Fig. 10) with longitudinal row of setae; galea longer than lacinia, with membranous apex, apex with rows or relatively long setae, several very long setae on apico-lateral surface (Figs. 8, 9), two large spinose setae on internal edge and mesal setae not extended along mesal surface. Labium (Fig. 4) with ligula slightly more than half as long as apparent first segment of labial palpus, deeply divided to near base into two divergent lobes, without sensory spines or pores; two medial setae present, bases close; medial pseudopore field narrow, with pseudopores; lateral pseudopore fields with setose pore, 2 real pores and pseudopores; labial palpi 2-articled (articles 1 and 2 fused), apparent article 1 about 2 times as long as article 2. Mentum with apex broadly emarginate and with characteristic pores and setae (Fig. 4). Hypopharyngeal lobes elongate, with large setae anteriorly and smaller setae posteriorly (Fig. 7).

Thorax: Prothorax more or less quadrate to slightly elongate (slightly transverse in



Figs. 2–10. *Gansia fortemaculata* n. sp., mouthparts. 2, labrum, dorsal aspect; 3, epipharynx (ventral aspect of labrum); 4, labium, ventral aspect; 5, mandible, dorsal aspect; 6, mandible, ventral aspect; 7, hypopharyngeal region of labium; 8, maxilla, ventral aspect; 9, galea, detail of dorsal aspect; 10, lacinia, detail of dorsal aspect.

a few species), broadest in apical ¼ and narrowed to near base (Figs. 1, 11–18); dorsal surface impressed medially to various degrees (Figs. 1, 11–18); anterior angles broadly rounded and very deeply depressed laterally; posterior angles strongly angulate, more or less flared laterally to produce slight sharp angles in most; posterior border broadly rounded and beaded. Microsculpture absent, integument strongly shining. Hypomeron fully visible in lateral aspect; hypomeron fully delimited by lateral bead or lateral bead absent anteriorly or totally absent. Prosternum extended posterior to tarsal insertions, with strong blade-like medial carina. Elytra somewhat inflated, dorsal surface of each elytron slightly convex in cross section (Figs. 1, 11–18); microsetae small and sparsely distributed; macrosetae absent; microsculpture absent, integument strongly shining. Mesosternum with strongly developed recurved anterior border, forming a distinct "neck"; without medial longitudinal carina, but with carina on each side of midline that fades before attaining the coxal cavities (Fig. 39). Mesocoxae moderately broadly separated by meso- and metasternal processes. Mesosternal process extended 0.4–0.5 times length of coxae, attaining and overlapping metasternal process; apex emarginate with apico-lateral angles produced as subspinose processes (Fig. 39), or apex broadly rounded. Metasternal process extended 0.5–0.6 times length of coxal cavities, broadly rounded apically. Isthmus absent because of overlap of metasternal process by mesosternal process. Legs long and slender, without conspicuous macrosetae; hind tarsomere 1 as long as, or longer than, 2 + 3 together. Tarsi 4-4-5 segmented.

Abdomen: More or less parallel-sided or slightly broader at segments VI–VII. Base of abdomen narrower than apex of elytra. Terga III–V deeply transversely impressed, impressions with prominent pores or longitudinal cariniform ridges, or both. Sterna III–V moderately to deeply transversely impressed, impressions with row of prominent pores or longitudinal cariniform ridges. Integument without microsculpture, strongly shining. Microsetae sparse and short; punctures (except for those in transverse impressions) minute to very small. Macrosetae large and prominent.

Secondary Sexual Characteristics: Absent in most. Males of some species with apex of abdominal sternum VIII modified to broad lobe, spiniform point or emarginate, with patches of variously modified setae and/or spines (Figs. 27, 49). Males of some species with scape and pedicel of antenna enlarged, and macrosetae of antennae much larger than those of females.

Aedeagus: Parameres distinctive (Figs. 21, 25, 34, 52), of two dramatically different forms: apical lobe variously elongated and some setae thickened and darkened (Figs. 21, 25, 34); or, apical lobe more or less quadrate or rectangular with a different setal arrangement (Fig. 52).

Spermatheca: Very elongate and doubly coiled (Figs. 22, 26, 31, 35, 40, 44) with small and elongate basal bulb.

Distribution: Previously described species are recorded from Guatemala, Brazil and Bolivia. We have seen specimens from throughout the Neotropics from Guerrero and Chiapas in southern México to Bolivia, including the countries of México, Guatemala, Honduras, Costa Rica, Panamá, Venezuela, Colómbia, Ecuador, Peru, Brazil and Bolivia.

Habitat, Feeding Habits and other Biological Information: Specimens have been collected from lowland tropical rainforests, montane tropical evergreen forests and cloud forests from 80–2,000 meters elevation. Specimens are occasionally collected

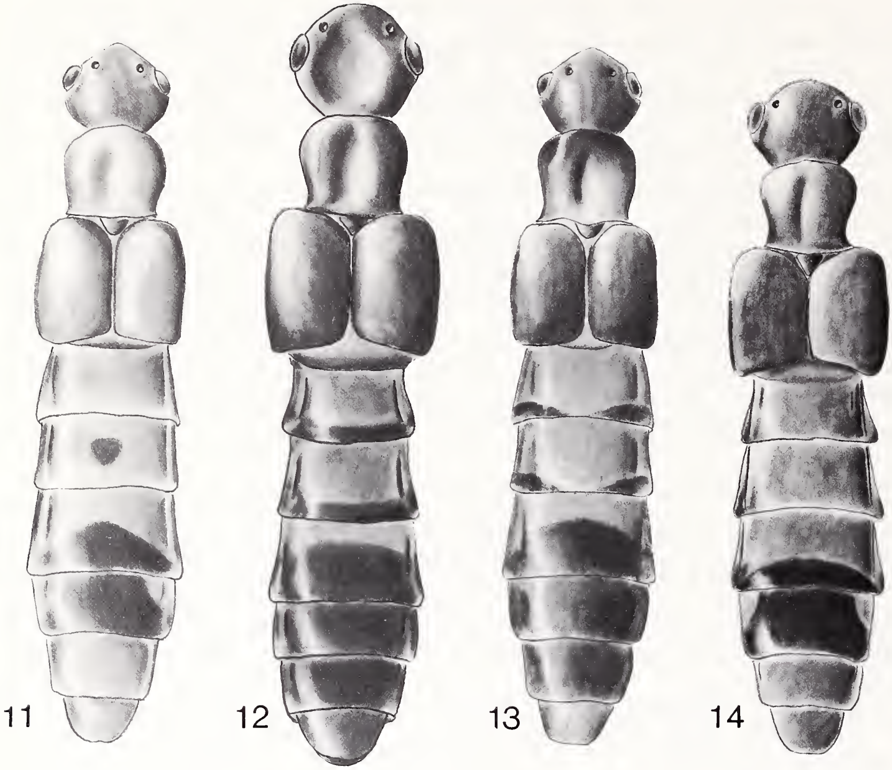
in leaf litter. However, one of the authors (Ashe) has consistently found adults associated with the rotting or fermenting leaves of treefalls or small branches that have fallen. These beetles are found so consistently and in such abundance in treefalls of the correct age that we are convinced that this is the primary habitat of members of *Gansia*. However, larvae that could be associated with adults of *Gansia* have not been identified in such habitats.

While dissecting specimens for examination of aedeagal characteristics, we discovered 20 adults representing numerous species, from throughout the range of the genus, with significant amounts of material in their guts. All such specimens had their guts filled with fungal hyphae and fungal spores including numerous diverse conidia and conidiospores. We were not able to find a single fragment of arthropod cuticle or other material that could be of animal origin among these gut contents. This surprising and consistent body of data provides strong evidence that members of *Gansia* are primarily fungivorus, apparently feeding on the fungi and molds that grow on rotting leaves and stems in treefalls and fallen branches.

KEY TO THE SPECIES OF *GANSIA* IN MÉXICO AND CENTRAL AMERICA

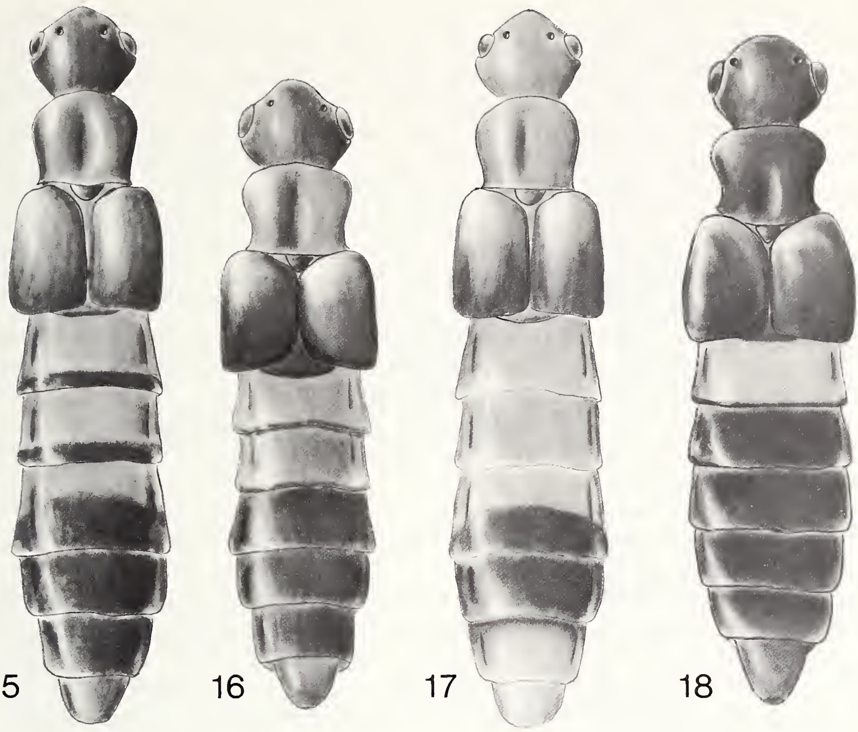
This key relies heavily on color pattern. *Gansia* is unusual among aleocharines in that color pattern is an excellent and consistent feature for recognizing species of this genus from México and Central America (see Figs. 1, 11–18). The color features used in this key will consistently allow identification of all *Gansia* specimens to which we had access. Other structural features and aedeagal characteristics are also used as required.

1. Sternum VI uniformly dark, piceus or black 4
   Sternum VI light, flavate or rufo-flavate with distinctly darker piceus band of variable width at apex 2
2. Metasternum and tergum II light, testaceus or rufo-flavate 3
   Metasternum and tergum II dark, piceus or dark reddish-brown (Fig. 11). Parameres as in Figure 21. Aedeagus as in Figures 19, 20 . . . . *G. andersoni*
3. Smaller, body length 2.3–2.5 mm. Transverse impression of abdominal tergum V with 4 large punctures, punctures distant, separated by smooth areas. Parameres as in Figure 43. Aedeagus as in Figures 32, 33 . . . . *G. flavata*
   Larger, body length 3.5 mm. Transverse impression of abdominal tergum V with 8 punctures, punctures close, separated by faintly developed longitudinal ridges *G. tibialis*
4. Tergum V bicolored, with light and dark areas (Figs. 1, 12, 13, 15, 17 6
   Tergum V uniformly piceus (Figs. 16, 18) 5
5. Pronotal impression deep and extended to, or nearly to, anterior margin of pronotum (Fig. 16). Terga III and IV pale flavate with narrow piceus area on anterior margin (Fig. 16). Head and pronotum brown, contrasting with piceus elytra. Metatibia piceus with lighter flavate apex. Tergum VIII reddish-brown, contrasting with piceus tergum VII (Fig. 16). Parameres as in Fig. 52. Aedeagus as in Figures 50, 51 . . . . . *G. taeniata*
   Pronotal impression shallow, restricted to basal half (Fig. 18). Tergum III uniformly pale flavate and tergum IV uniformly piceus (tergum IV of some specimens with extreme basal margin paler) (Fig. 18). Head, pronotum and elytra piceus. Metatibia uniformly pale rufo-flavate. Tergum VIII piceus, similar in color to tergum VII (Fig. 18). Parameres as in Figure 58. Aedeagus as in Figures 57, 59 . . . . *G. unizonata*
6. Head distinctly impressed medially (Figs. 1, 12). Males with enlarged macrosetae on antennal articles 1 and 2 7
   Head not at all impressed medially. Male antennae without enlarged macrosetae 8



Figs. 11–14. Dorsal habitus of selected *Gansia* species. 11, *Gansia andersoni* n. sp.; 12, *G. bicolor* Sharp; 13, *G. bipictanota* n. sp.; 14, *G. flavata* n. sp.

7. Terga III–V flavate with piceus or black basal band in posterior half to ⅔ and medial region of basal dark band strongly extended in an arc anteriorly nearly to basal margin (Fig. 1). Parameres as in Figure 38. Aedeagus as in Figures 36, 37 . . . *G. fortemaculata*
   Terga III–V flavate with piceus or black band in posterior half to ⅔ of uniform width throughout, medial area not arcuately extended anteriorly (band on tergum V slightly and broadly arcuate medially in some specimens) (Fig. 12). Parameres as in Figure 25. Aedeagus as in Figures 23, 24 . . . . *G. bicolor*
8. Abdominal segments VII–VIII light, rufo-flavate to flavate (some specimens with basal half of tergum VII darker), contrasting with piceus to black segment VI (Fig. 17). Hind femur flavate with piceus apical ¼–⅓. Parameres as in Figure 56. Aedeagus as in Figures 53, 54 . . . . *G. tergopunctata*
   Abdominal segments VII–VIII dark, piceus to black, similar in color to segment VI (segment VIII slightly lighter brownish in some teneral specimens) (Figs. 13, 15). Hind femur piceus with flavate basal ⅓–¼ 9
9. Pronotum coarsely punctate, punctures clearly visible at 25× magnification; distance between punctures about 1.5–2.0 times width of punctures. Parameres as in Figure 47. Aedeagus as in Figures 45, 46 . . . . *G. tachynota*
   Pronotum very minutely punctate, punctures not apparent and pronotum appearing



Figs. 15–18. Dorsal habitus of selected *Gansia* species. 15, *G. tachynota* n. sp.; 16, *G. taeniata* n. sp.; 17, *G. tergopunctata* n. sp.; 18, *G. unizonata* n. sp.

smooth at 25× magnification; distance between punctures more than 4× width of punctures 10

10. Punctures in transverse impressions of abdominal terga III–V relatively small and numerous (14–16 punctures on tergum IV), arranged in 2 irregular rows. Most specimens with bicolored pronota, apical half piceus to dark reddish-brown and basal half brown to rufo-flavate (Fig. 13). Parameres as in Figure 30. Aedeagus as in Figures 28, 29 . . . . *G. bipictanota*

Punctures in transverse impressions of abdominal terga III–V larger and fewer (4, rarely 6, punctures on tergum IV), arranged in a single row of large, more distant punctures. Pronotum uniformly piceus, brown or reddish brown (some specimens with narrow and diffuse band of lighter color at base). Parameres as in Figure 41. Aedeagus as in Figures 42, 43 . . . . *G. obscura*

SPECIES DESCRIPTIONS

Gansia andersoni, n. sp.

(Figs. 11, 19–22; Map 1)

Description: (Fig. 11) Length of elytra 0.51–0.56 mm. Width of head including eyes, 0.47–0.49 mm. Ratio of length to width of pronotum 0.88–0.92.

Head without medial impression. Pronotum with medial impression distinct to anterior margin. Surface of pronotum finely punctured, somewhat shiny. Head and pronotum pale rufo-flavate. Elytral color piceus to reddish brown. Prosternum and mesosternum rufo-flavate; metasternum piceus.

Tergum II piceus. Abdominal terga III–IV rufoflavate except for slight piceus postero-lateral corners. Tergum IV with a centrally located piceus spot. Tergum V with basal half rufo-flavate and posterior half piceus; piceus band strongly arcuate anteriorly in middle. Tergum VI piceus except for rufo-flavate antero-lateral corners. Terga VII–VIII rufo-flavate or light reddish-brown. Sterna III–IV rufo-flavate except for piceus postero-lateral corners. Sterna V–VI pale except for extreme posterior margin which is piceus. Sterna VII–VIII completely rufo-flavate.

Protibia piceus in at least the proximal half. Mesotibia and metatibia piceus except for lighter apex. Profemur, mesofemur, and metafemur pale orange to reddish-brown; apices piceus in some. Metatrochanter pale orange.

Transverse impressions of abdominal terga III–V each with 2 irregular rows of moderate sized, closely arranged punctures; about 12 punctures on tergum III, 14 on tergum IV, 16 on tergum V.

Secondary Sexual Characteristics: Absent.

Male: Parameres as in Figure 1; median lobe as in Figures 19, 20.

Female: Spermatheca as in Figure 22.

Type Material: HOLOTYPE, male, here designated, with labels as follows: "MÉXICO: Chiapas, Volcán Tacaná, lower slopes, 4 km N Union Juarez, 1,800 m, 18 September 1992, R. S. Anderson 92-109, ex. cloud forest litter," "HOLOTYPE, *Gansia andersoni* Ashe and Lingafelter, Desig. J. Ashe and S. Lingafelter, 1996." Holotype in the collection of the Snow Entomological Museum, University of Kansas, Lawrence, Kansas.

PARATYPES: 8. Same locality, collector, and habitat, 1,800 m, 1,950 m, 2,000 m, 18–19 September 1992 (6 KSEM); same locality, 1,600 m, Barranca Providencia, 24 December 1975. H. Frania #209-75, ex. vegetation overhanging road cut, montane tropical forest (2 AMNH).

Distribution: Known only from Volcán Tacaná in southern México (Chiapas) (Map 1).

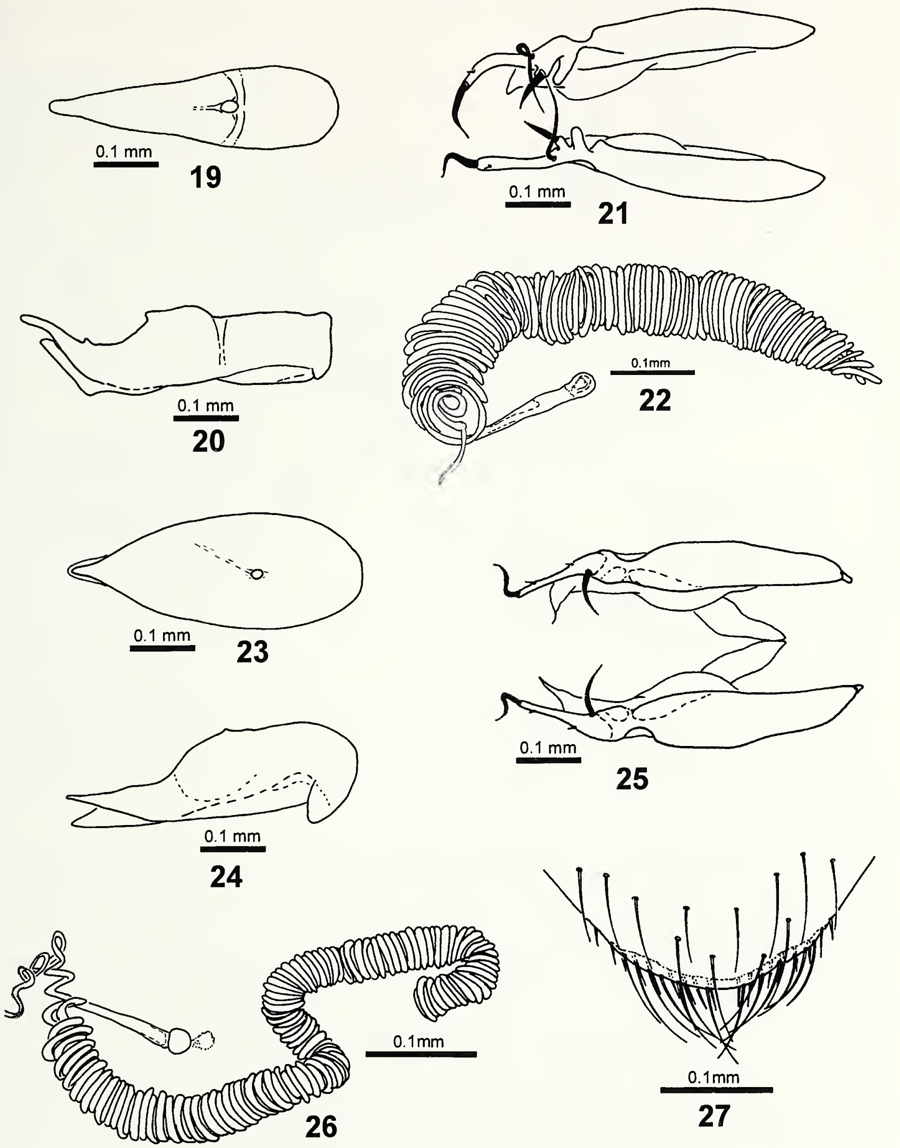
Bionomics: Collected from 1,600–2,000 m in cloud forest litter and vegetation overhanging road cut.

Etymology: This elegant and beautiful staphylinid is named in honor of Dr. Robert S. Anderson, Canadian Museum of Nature, Ottawa, Canada, who collected most of the known specimens of this species while searching for leaf-litter weevils in cloud forests on Volcán Tacaná.

Comments: *G. andersoni* is similar in color pattern to *G. tibialis* and *G. flavata.* However, it can be easily distinguished from these latter species by the presence of a dark spot on abdominal tergum VII, and a piceus metasternum and abdominal tergum II (Fig. 11), as well as by the distinctive aedeagus (Figs. 19, 20) and parameres (Fig. 21).

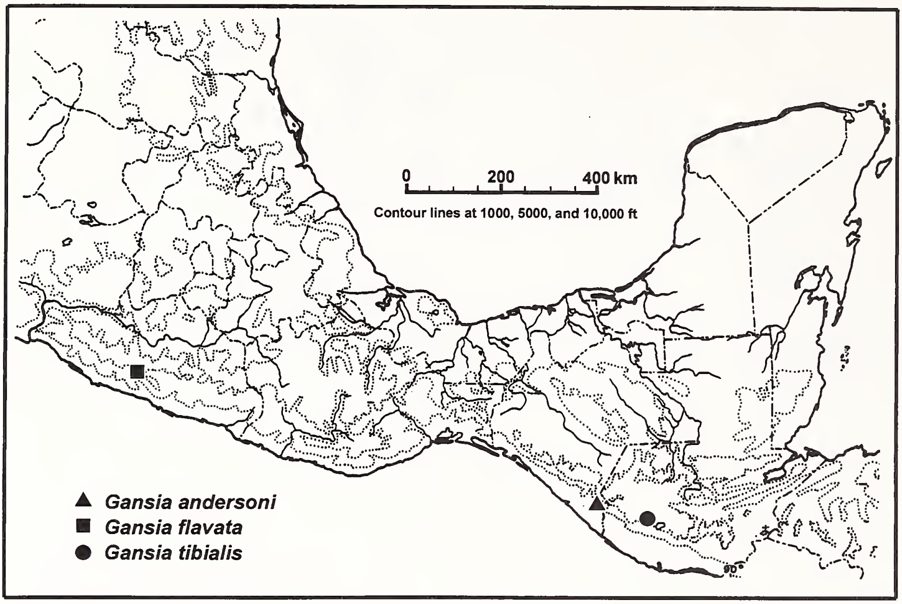
Gansia bicolor Sharp
(Figs. 12, 23–27; Map 2)

Description: (Fig. 12) Length of elytra 0.52–0.55 mm. Width of head including eyes, 0.47–0.49 mm. Ratio of length to width of pronotum 0.94–0.99.



Figs. 19–22. *Gansia andersoni* n. sp. 19, median lobe of aedeagus, dorsal aspect; 20, medial lobe of aedeagus, lateral aspect; 21, parameres of aedeagus, ventral aspect; 22, spermatheca.

Figs. 23–27. *Gansia bicolor* Sharp. 23, median lobe of aedeagus, dorsal aspect; 24, medial lobe of aedeagus, lateral aspect; 25, parameres of aedeagus, ventral aspect; 26, spermatheca; 27, apical margin of male abdominal sternum VIII, secondary sexual characteristics.



Map 1. Collection localities for *Gansia andersoni* n. sp., *G. flavata* n. sp., and *G. tibialis* Sharp.

Head with deep and broad impression. Pronotum with deep impression to anterior margin. Surface of pronotum finely punctured, somewhat shiny. Head and pronotum piceus. Elytra piceus (lighter at base in some). Prosternum, mesosternum and metasternum piceus.

Tergum II piceus. Terga III–IV flavate except for piceus posterior margin, piceus band not medially arcuate. Tergum V with basal half flavate and posterior half piceus, piceus band not medially arcuate to slightly and broadly arcuate in some specimens. Terga VI–VIII completely piceus.

Sterna III–IV flavate except for piceus postero-lateral corners. Sterna V piceus except for flavate extreme basal margin. Sterna VI–VII completely piceus to dark reddish brown. Sterna VIII piceus (lighter at apex in some).

Protibia piceus in at least the proximal half. Mesotibia and metatibia mostly piceus except for lighter apex. Profemur pale orange to reddish-brown. Mesofemur piceus to dark reddish-brown. Metafemur piceus. Metatrochanter white.

Transverse impressions of terga III–IV with 4 large punctures arranged in a single row.

Secondary Sexual Characteristics: Antennal scape of male strongly clavate; macrosetae of antennal articles 1–4 greatly enlarged. Abdominal sternum VIII with apical lobe covered with modified setae and a row of small spines internally (Fig. 27).

Male: Parameres as in Figure 25; median lobe as in Figures 23, 24.

Female: Spermatheca as in Figure 26.

Type Material: LECTOTYPE, male, here designated, with labels as follows: *Gansia*

Map 2. Collection localities for *Gansia unizonata* n. sp., *G. bicolor* Sharp, and *G. bipictanota* n. sp.

bicolor, Type, D. S., El Zumbador, 2,500', Champion," small red "Type" label, "El Tumbador, Guatemala," "Sharp Coll. 1905-313," "B.C.A. Col. 1.2., *Gansia bicolor* Sharp," "LECTOTYPE, male, *Gansia bicolor* Sharp, desig, J. Ashe and S. Lingafelter, 1996." PARALECTOTYPES, 9, here designated; same data as type, 6; Guatemala, Cerro Zunil, Champion, 3. Lectotype and 8 paralectotypes in Natural History Museum, London, and Paralectotype in the Field Museum of Natural History, Chicago. The specimen labeled "Lectotype" is on a card with 2 specimens, a male and a female; the male is designated as the lectotype and the female is designated as the paralectotype.

Other Material Examined: 27 specimens. GUATEMALA: Quetzaltenango, 14.4 km W Zunil, 1340 m, 21 June 1993, J. Ashe, R. Brooks #076, ex rotting elephant ear leaves (1 KSEM). COSTA RICA: Puntarenas, Las Alturas (Stanford Biol. Sta.), ca 25 km NE San Vito, 1,500 m, 25 May 1993, J. & A. Ashe, ex treefall litter (2 KSEM), same locality, October 1991, P. Hanson (1 KSEM); Tapantí, 9-IX-1939, no collector (Bierig Collection), (3 FMNH); same locality, 22-VII-1939, no collector (Bierig Collection), (1 FMNH). PANAMÁ: Chiriquí, 20 km N Gualaca, Finca La Suiza, 08°39'N, 82°12'W, 1,350 m, 22 May 1994, J. & A. Ashe, ex treefall litter (14, KSEM), same locality, 10 June 1994, J. Ashe and R. Brooks, ex tree slash (5 KSEM).

Distribution: Occurring widely from Guatemala, Costa Rica (Puntarenas Prov.) and Panamá (Chiriquí Prov.) (Map 2).
Bionomics: Occurring at altitudes of 1,340–1,500 m. Collected from slash, treefall litter, and rotting elephant ear leaves.
Comments: *G. bicolor* is similar to *G. fortemaculata*; these are the only known species in México and Central America that have a medially impressed head and in which males have greatly enlarged setae on the basal antennal articles. *G. bicolor* can be easily distinguished from *G. fortemaculata* by the presence of dark piceus band on the basal abdominal segments (terga III–V) that are not arcuately expanded anteriorly (Fig. 12). In contrast, the piceus bands are strongly and arcuately expanded anteriorly in *G. fortemaculata* (Fig. 1).

Gansia bipictanota, n. sp.
(Figs. 13, 28–31; Map 2)

Description: (Fig. 13) Length of elytra 0.49–0.53 mm. Width of head including eyes, 0.44–0.45 mm. Ratio of length to width of pronotum 0.89–0.93.

Head without distinct medial impression. Pronotum with distinct medial impression to anterior margin. Surface of pronotum finely punctured, shining.

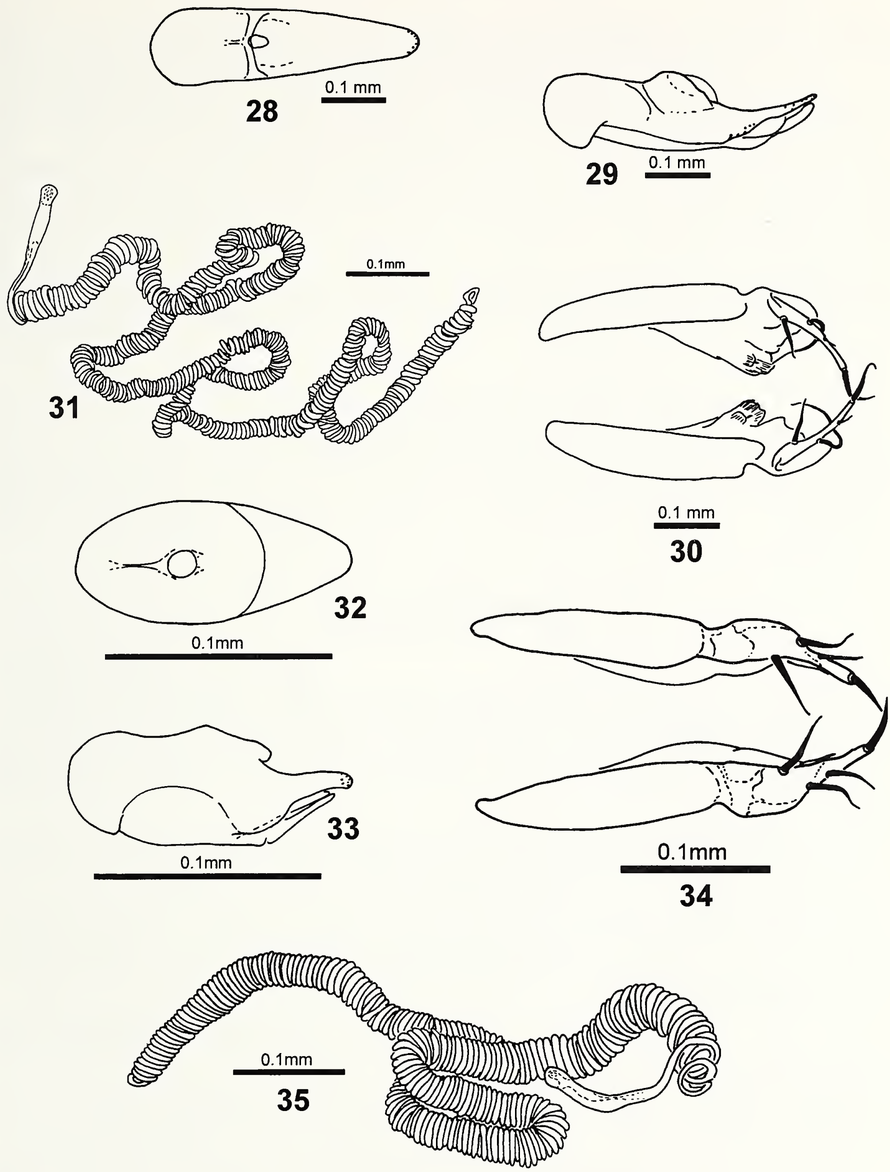
Head dark reddish brown. Pronotum piceus to dark reddish brown in anterior half and brown to rufo-flavate in posterior half. Elytral color black to piceus (lighter at base in some). Prosternum and mesosternum dark reddish-brown; metasternum black to piceus.

Abdominal tergum II piceus. Terga III–IV flavate except for piceus posterior margin. Tergum V with basal half flavate and posterior half piceus; piceus band strongly arcuate medially. Terga VI–VII completely piceus. Tergum VIII variable in color, completely piceus to brown.

Sterna III–IV flavate except for piceus postero-lateral corners. Sternum V with basal half flavate and posterior half piceus. Sterna VI–VII completely piceus to dark reddish brown. Sternum VIII piceus (lighter at apex in some).

Protibia piceus in the basal half to two-thirds, flavate apically. Mesotibia and metatibia piceus except for lighter flavate at extreme apex. Profemur light brown throughout. Mesofemur piceus except for lighter extreme base. Metafemur piceus in apical two-thirds and flavate in basal third. Metatrochanter white.

Transverse impressions of abdominal terga III–V each with 2 irregular rows of 12–14 small, closely arranged punctures.
Secondary Sexual Characteristics: Males with sternum VIII similar to those of *G. tachynota* (see Fig. 49).
Male: Parameres as in Figure 30; median lobe as in Figures 28, 29.
Female: Spermatheca as in Figure 31.
Type Material: HOLOTYPE, male, here designated, with labels as follows: "PANAMÁ, Chiriquí Prov., 20.4 km N San Felix, 08°22′N, 81°46′W, 950 m, 8 June 1995, J. Ashe & R. Brooks #146, ex banana leaf slash," "HOLOTYPE, *Gansia bipictanota* Ashe and Lingafelter, Desig. J. Ashe and S. Lingafelter, 1996." Holotype in the collection of the Snow Entomological Museum, University of Kansas, Lawrence, Kansas.
PARATYPES: 23. Same data as holotype (1 KSEM); same locality, date and col-



Figs. 28–31. *Gansia bipictanota* n. sp. 28, median lobe of aedeagus, dorsal aspect; 29, median lobe of aedeagus, lateral aspect; 30, parameres of aedeagus, ventral aspect; 31, spermatheca.

Figs. 32–35. *Gansia flavata* n. sp. 32, median lobe of aedeagus, dorsal aspect; 33, median lobe of aedeagus, lateral aspect; 34, parameres of aedeagus, ventral aspect; 35, spermatheca.

lectors, #144, 145, ex treefall litter, roadside slash (2 KSEM). COSTA RICA: Chitarla, 17–20 February 1943, no collector (Bierig collection) (1 FMNH); Alenas, 750 m, 1 March 1839, no collector (Bierig collection) (2 FMNH); Guanacaste Prov., Patilla Biol. Sta. 10°58′N, 85°26′W, 650 m, 2 May 1995, J. Ashe, ex treefall litter (5 KSEM); same locality, 700 m, 1988, Malaise trap (4 INBI).

Distribution: Known from Costa Rica (Guanacaste Prov.) and Panamá (Chiriquí Prov.) (Map 2).

Bionomics: Collected from treefall litter, roadside slash and banana leaf slash from 650–950 m.

Etymology: From "pictum" (L. painted, colored), "notum" (referring to the pronotum) and the prefix "bi-" (two), referring to the distinctly bicolored pronotum of most specimens of this species.

Comments: Most specimens of *G. bipictanota* can be easily distinguished from all other Central American *Gansia* by the combination of: 12–14 punctures in the transverse impression of terga III-V, bicolored pronotum, and the dark apex of the abdomen (Fig. 12). However, some lighter specimens of *G. bipictanota* are difficult to distinguish from dark specimens of *G. tergopunctata* (see comments under *G. tergopunctata*).

Gansia flavata, n. sp.

(Figs. 14, 32–35; Map 1)

Description: (Fig. 14) Length of elytra 0.44–0.49 mm. Width of head including eyes, 0.39–0.41 mm. Ratio of length to width of pronotum 0.89–0.90.

Head without distinct medial impression. Pronotum with shallow impression not attaining anterior margin. Surface of pronotum coarsely punctured, somewhat opaque.

Head and pronotal color pale rufo-flavate. Elytral color pale rufo-flavate. Prosternum, mesosternum and metasternum rufo-flavate.

Abdominal tergum II rufo-flavate. Terga III-IV uniformly rufo-flavate. Tergum V rufo-flavate except for piceus posterior margin which is slightly arcuate in some. Tergum VI piceus except for rufo-flavate antero-lateral corners. Terga VII–VIII rufo-flavate or light reddish-brown.

Sterna III–IV rufo-flavate except for minute area of piceus color at postero-lateral corners. Sterna V–VI rufo-flavate except for extreme posterior margin which is piceus. Sterna VII–VIII completely rufo-flavate.

Protibia, mesotibia, and metatibia pale rufo-flavate. Profemur, mesofemur, and metafemur pale rufo-flavate to reddish-brown. Metatrochanter pale rufo-flavate.

Transverse impressions of terga III–IV with four large punctures arranged in a single row, punctures separated by broad smooth areas.

Secondary Sexual Characteristics: Absent.

Male: Parameres as in Figure 34; median lobe as in Figures 32, 33.

Female: Spermatheca as in Figure 35.

Type Material: HOLOTYPE, male, here designated, with labels as follows: "MÉXICO: Guerrero, 63.2 km NE Atoyac de Alvarez, 1,300 m, 28 July 1992, J. Ashe #136, ex treefall litter," "HOLOTYPE, *Gansia flavata* Ashe and Lingafelter, Desig.

J. Ashe and S. Lingafelter, 1996." Holotype in the collection of the Snow Entomological Museum, University of Kansas, Lawrence, Kansas.
PARATYPES: 4, same data as holotype (KSEM).
Distribution: Known only from the Sierra Madre del Sur in southern México (Guerrero) (Map 1).
Bionomics: Collected at 1,300 m in treefall litter.
Etymology: From "flavus" (L., yellow), referring to the light reddish-yellow color of specimens of this species.
Comments: *G. flavata* is very similar to *G. tibialis* in color pattern, but it may be distinguished from this latter species by its smaller size and the presence of only four well-separated punctures in the transverse impressions of terga III–V (6–8 in *G. tibialis*).

Gansia fortemaculata, n. sp.
(Figs. 1, 36–40; Map 3)

Description: (Fig. 1) Length of elytra 0.52–0.57 mm. Width of head including eyes, 0.49–0.52 mm. Ratio of length to width of pronotum 0.90–0.98.

Head with deep and broad medial impression. Pronotum with deep medial impression to anterior margin. Surface of pronotum finely punctured, somewhat shiny.

Head color piceus. Pronotal color dark reddish brown. Elytral color piceus (lighter at base in some). Prosternum reddish brown; mesosternum dark reddish brown; metasternum piceus.

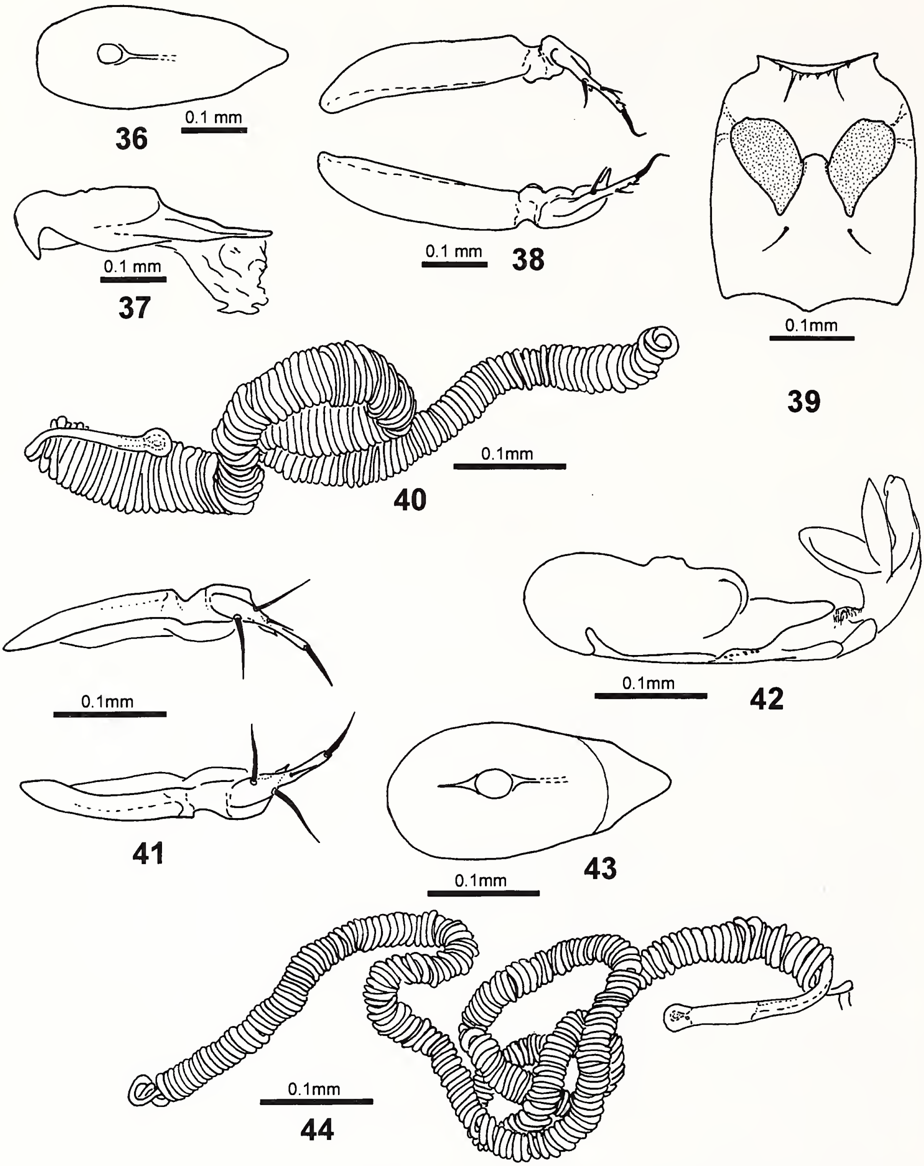
Terga III–V flavate on basal half with piceus band on posterior half which is arcuately lobed medially to attain, or nearly attain, anterior margin (piceus band on tergum V less strongly arcuate in some specimens). Terga VI–VIII completely piceus.

Sterna III-IV flavate except for piceus postero-lateral corners. Sternum V piceus except for extreme basal margin. Sterna VI–VII completely piceus to dark reddish brown. Sterna VIII piceus (sometimes lighter at apex).

Protibia piceus in at least the proximal one-half. Mesotibia and metatibia piceus except for lighter apex. Profemur pale orange to reddish-brown. Mesofemur piceus to dark reddish-brown. Metafemur piceus. Metatrochanter white.

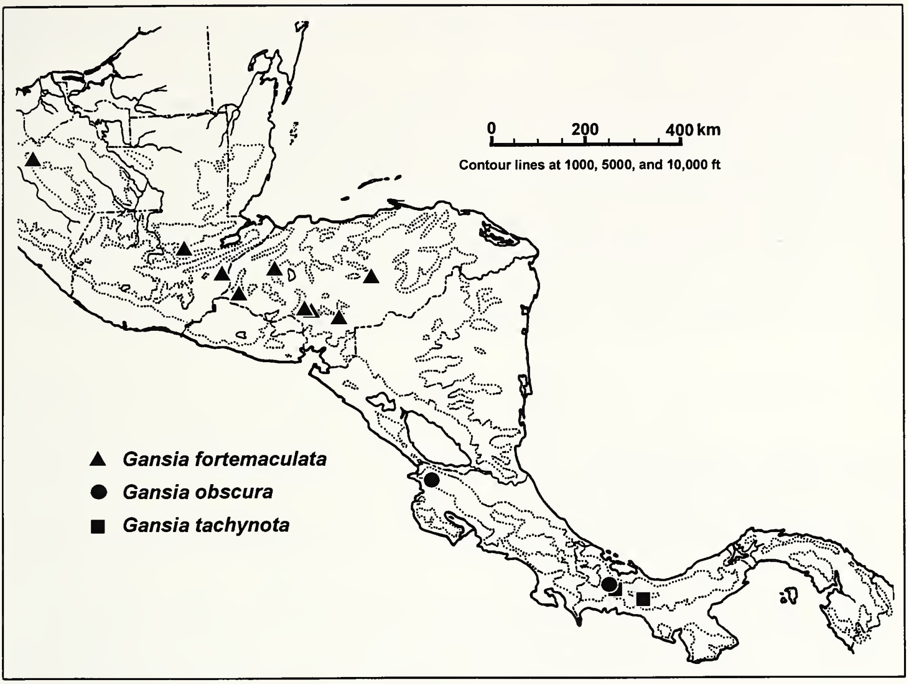
Transverse impressions of terga III–IV with 4 large, moderately separated, punctures arranged in a single row.

Secondary Sexual Characteristics: Male antennal scape strongly clavate; macrosetae of antennal articles 1–4 greatly enlarged. Male sternum VIII with apical lobe covered with modified setae and a row of small spines internally (similar to that of *G. bicolor,* Fig. 27).
Male: Parameres as in Figure 38; median lobe as in Figures 36, 37.
Female: Spermatheca as in Figure 40.
Type Material: HOLOTYPE, male, here designated, with labels as follows: "HONDURAS: Olancho, La Muralla, 14 km N La Union, 1,450 m, 15°06′N, 86°42′W, 25VI1994, J. Ashe, R. Brooks, #203, ex treefall litter," "HOLOTYPE, *Gansia fortemaculata* Ashe and Lingafelter, Desig. J. Ashe and S. Lingafelter, 1996." Holotype in the collection of the Snow Entomological Museum, University of Kansas, Lawrence, Kansas.



Figs. 36–40. *Gansia fortemaculata* n. sp. 36, median lobe of aedeagus, dorsal aspect; 37, median lobe of aedeagus, lateral aspect; 38, parameres of aedeagus, ventral aspect; 39, meso-metasternum, ventral aspect; 40, spermatheca.

Figs. 41–44. *Gansia obscura* n. sp. 41, parameres of aedeagus, ventral aspect; 42, median lobe of aedeagus, lateral aspect, internal sac everted; 43, median lobe of aedeagus, dorsal aspect; 44, spermatheca.



Map 3. Collection localities for *Gansia fortemaculata* n. sp., *G. obscura* n. sp., and *G. tachynota* n. sp.

PARATYPES: 101. MÉXICO: Chiapas, 10 km W El Bosque, 1,475 m, 15 September 1992, R. S. Anderson 92-103, ex pine/cloud forest litter (2 KSEM); GUATEMALA: Baja Verapaz, 4.8 km E Purulha, 1680 m, 29 June–3 July 1993, J. Ashe and R. Brooks #190, ex flight intercept trap (1 KSEM), 8 km S Purulha, 1,650 m, 29 June 1993, J. Ashe. R. Brooks #149, ex *Cecropia* treefall (1 KSEM); Zacapa, 3.5 km SE La Union, 1,500 m, 4 June 1991, R. S. Anderson 91-50, ex cloud forest litter (4 KSEM); same locality, 1,500 m, 23 June 1993, Anderson and Ashe 93-12D, berlese forest litter (8 KSEM); same locality, 1,500 m, 23 June 1993, J. Ashe, R. Brooks #085, ex treefall litter (15 KSEM); same locality, elevation and collectors #103, 22–23 June 1993, ex flight intercept trap (1 KSEM); HONDURAS: El Paraiso, 6.9 km W Yuscaran, Cerro Monserrat, 1,760 m, 13°55′N, 86°24′W, 7 June 1994, J. Ashe & R. Brooks #020-21, ex treefall litter (23 KSEM); same locality, date and collector, #026, ex in moist leaf packs of fallen tree (1 KSEM); 19.4 km SE Zamarano & 9.4 km SE Galeras, 1,450 m, 13°24′N, 86°55′W, "Los Lavanderos," 11 June 1994, J. Ashe, R. Brooks #075, ex treefall litter (1 KSEM); Francisco Morazan, Yerba Buena, 36.9 km W Tegucigalpa, 1,920 m, 14°05′N, 87°34′W, 28 June 1994, J. Ashe, R. Brooks #232, ex treefall slash (21 KSEM); Ocotepeque, 12.7 km E & 2.4 km S Ocotepeque, 1,450 m, 14°27′N, 89°04′W, 15 June 1994, J. Ashe, R. Brooks #115, ex treefall litter (2 KSEM); Olancho, La Muralla, 14 km N La Union, 1,450 m, 15°06′N, 86°42′W, 25 June 1994, J. Ashe, R. Brooks #203, ex treefall litter (23

KSEM); Santa Barbara, Mt. Santa Barbara, 11.5 km S & 5.6 km W Peña Blanca, 14°57′N, 88°06′W, 1,800 m, 20 June 1994, J. Ashe, R. Brooks #163, ex decaying slash (1 KSEM).

Distribution: México (Chiapas) to Guatemala and Honduras (Map 3).

Bionomics: Collected from 1,450–1,900 m in treefall litter, decaying slash, cloud-forest litter, moist leaf packs of a fallen tree, and in flight intercept traps.

Etymology: From "fortis" (L., strong) and "macula" (L., marked), referring to the very striking light and dark markings on the basal abdominal segments.

Comments: *G. fortemaculata* is most similar to *G. bicolor,* but may be distinguished by the characters noted in the comments section of *G. bicolor* as well as by the distinctive aedeagus (Figs. 36, 37) and parameres (Fig. 38) of *G. fortemaculata.*

Gansia obscura, n. sp.
(Figs. 41–44; Map 3)

Description: Length of elytra 0.48–0.49 mm. Width of head including eyes, 0.47–0.49 mm. Ratio of length to width of pronotum 0.96.

Head without distinct medial impression. Pronotum with distinct medial impression to anterior margin. Surface of pronotum finely punctured, somewhat shiny.

Head and pronotal color dark reddish brown. Elytral color piceus (lighter at base in some). Prosternum and mesosternum dark reddish-brown; metasternum piceus.

Abdominal tergum II piceus. Terga III–V flavate except for piceus posterior margin; piceus band of tergum V slightly to moderately arcuate medially in some. Terga VI–VII completely piceus. Tergum VIII variable in color from completely piceus to brown.

Sterna III–V flavate except for piceus postero-lateral corners. Sterna V with basal half flavate and posterior half piceus. Sterna VI–VII completely piceus or dark reddish brown. Sternum VIII brownish.

Protibia piceus in at least the proximal half. Mesotibia and metatibia piceus except for lighter apex. Profemur and mesofemur pale rufo-flavate to reddish-brown. Metafemur piceus except for flavate basal fourth to third. Metatrochanter white.

Transverse impressions of terga III–IV with four (rarely six) large, moderately separated, punctures arranged in a single row.

Secondary Sexual Characteristics: Males with sternum VIII similar to those of *G. tachynota* (see Fig. 49).

Male: Parameres as in Figure 41; median lobe as in Figures 42, 43.

Female: Spermatheca as in Figure 44.

Type Material: HOLOTYPE, male, here designated, with labels as follows: "COSTA RICA: Guanacaste, Cacao Biol. Sta., 11°55′N; 85°30′W, 5 May 1995, J. Ashe, ex treefall litter," "HOLOTYPE, *Gansia obscura* Ashe and Lingafelter, Desig. J. Ashe and S. Lingafelter, 1996." Holotype in the collection of the Snow Entomological Museum, University of Kansas, Lawrence, Kansas.

PARATYPES: 7. Same data as holotype (4 KSEM); COSTA RICA: Finca Castilla, 6–9-II-1940, no collector (Bierig Collection) (2 FMNH). PANAMÁ: Chiriquí Prov., La Fortuna, "Cont. Divide Trial," 08°46′N, 82°12′W, 1,150 m, 9 June 1995, J. Ashe, R. Brooks #151, ex slash (1 KSEM).

Distribution: Known from Costa Rica (Guanacaste Prov.) and Panamá (Chiriquí Prov.) (Map 3).
Bionomics: Collected in treefall litter and slash from 1,000–1,150 m.
Etymology: From "obscurus" (L., dark, indistinct), referring to the relatively indistinctive external features of this species.
Comments: *G. obscura* is similar to *G. tachynota* in color pattern and number and arrangement of punctures in the transverse impressions of terga III–V. However, they can be easily distinguished from this latter species by the very finely punctate pronota of specimens of *G. obscura* (see comments under *G. tachynota*).

Gansia tachynota, n. sp.
(Figs. 15, 45–49; Map 3)

Description: (Fig. 15) Length of elytra 0.45 mm. Width of head including eyes, 0.44–0.45 mm. Ratio of length to width of pronotum 0.92–0.93.

Head without distinct medial impression. Pronotum with distinct medial impression to anterior margin. Surface of pronotum coarsely punctured, somewhat opaque.

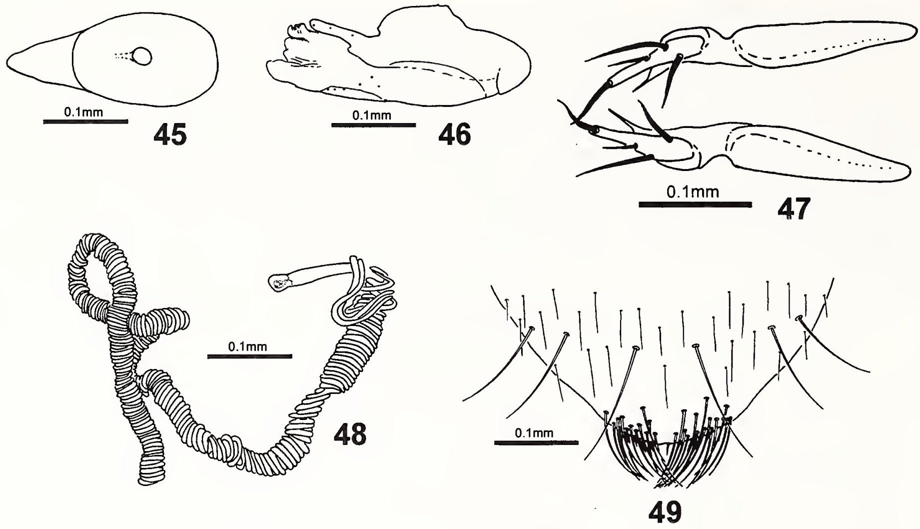
Head and pronotal color light to dark reddish brown. Elytral color piceus (lighter at base in some). Prosternum and mesosternum dark reddish-brown; metasternum piceus.

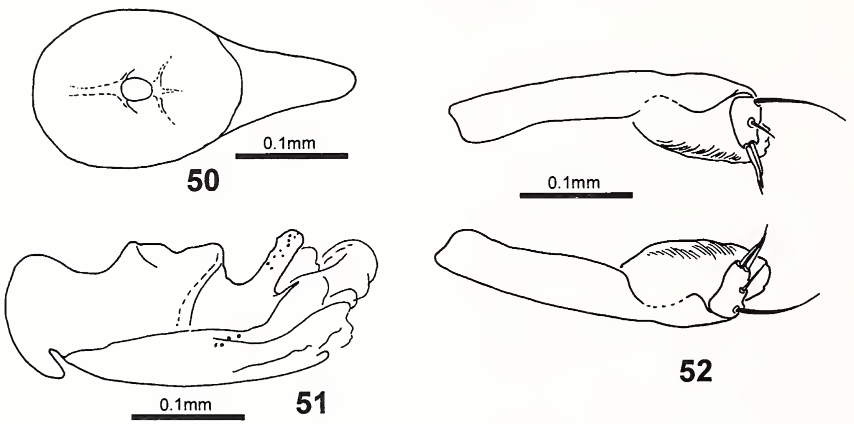
Abdominal tergum II piceus. Terga III–IV flavate except for piceus posterior margin. Tergum V with basal half flavate and posterior half piceus; piceus band strongly arcuate medially. Terga VI–VII completely piceus. Tergum VIII variable in color, completely piceus to brown.

Sterna III–IV flavate except for piceus posterior-lateral corners. Sternum V with basal half flavate and posterior half piceus. Sterna VI–VII completely piceus to dark reddish brown. Sternum VIII piceus (lighter at apex in some).

Protibia piceus in at least the proximal half. Mesotibia and metatibia piceus except for lighter apex. Profemur pale rufo-flavate to reddish-brown. Mesofemur piceus to dark reddish-brown. Metafemur piceus. Metatrochanter white.

Transverse impressions of terga III–IV with 4 large, moderately separated, punctures arranged in a single row.
Secondary Sexual Characteristics: Male abdominal sternum VIII with apical lobe covered with modified setae and an apical row of small spines (Fig. 49).
Male: Parameres as in Figure 47; median lobe as in Figures 45, 46.
Female: Spermatheca as in Figure 48.
Type Material: HOLOTYPE, male, here designated, with labels as follows: "PANAMÁ, Chiriquí Prov., 20.4 km N. San Felix, 08°22′N, 81°46′W, 950 m, 8 June 1995, J. Ashe & R. Brooks #144, ex treefall litter," "HOLOTYPE, *Gansia tachynota* Ashe and Lingafelter, Desig. J. Ashe and S. Lingafelter, 1996." Holotype in the collection of the Snow Entomological Museum, University of Kansas, Lawrence, Kansas.
PARATYPES: 13. Same data as holotype (7 KSEM): PANAMÁ: Chiriquí Prov., 10.5 km NE Caldera, 08°42′N, 83°19′W, 340 m, 24 May 1995, J. & A. Ashe #058, ex treefall litter (1 KSEM); Cerro Mogla, Qda. Tufino, 1,175 m, 22 January 1981, W. Suter, ferns and mosses, wall nr. cascades (5 FMNH).
Distribution: Known only from Panamá (Chiriquí Prov.) (Map 3).
Bionomics: Collected from 340–1,175 m in treefall litter and ferns and mosses.



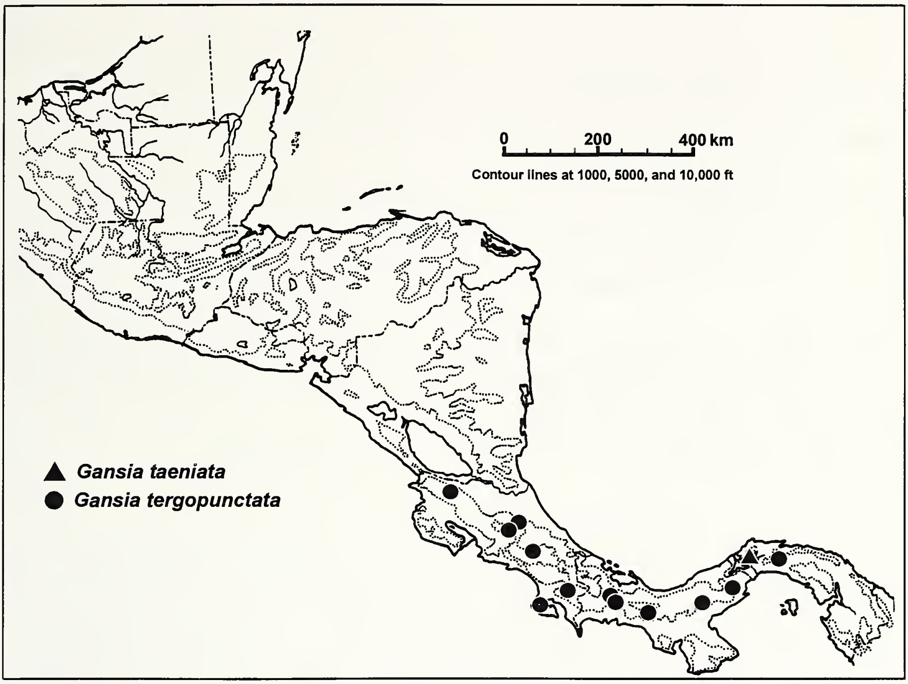


Figs. 45–49. *Gansia tachynota* n. sp. 45, median lobe of aedeagus, dorsal aspect; 46, medial lobe of aedeagus, lateral aspect; 47, parameres of aedeagus, ventral aspect; 48, spermatheca; 49, apex of male abdominal sternum VIII, secondary sexual characteristics.

Figs. 50–52. *Gansia taeniata* n. sp. 50, median lobe of aedeagus, dorsal aspect; 51, median lobe of aedeagus, lateral aspect; 52, parameres of aedeagus, ventral aspect.

Etymology: From "tachys" (Gr. rough) and "notum" (Gr. referring to the pronotum), referring to the relatively coarsely punctate pronotum of members of this species.

Comments: This species is easily distinguished by the combination of its distinctive color patten (Fig. 15) and the relatively large and numerous punctures on the pronotum. It is similar in color pattern, number and distribution of punctures in the transverse impression of terga III–V, and secondary sexual characteristics, to *G.*



Map 4. Collection localities for *Gansia taeniata* n. sp. and *G. tergopunctata* n. sp.

obscura. However, specimens of this latter species have extremely minute punctures on the pronotum.

Gansia taeniata, n. sp.
(Figs. 16, 50–52; Map 4)

Description: (Fig. 16) Length of elytra 0.46–0.49 mm. Width of head including eyes, 0.41–0.45 mm. Ratio of length to width of pronotum 0.79–0.88.

Head without distinct impression. Pronotum with impression distinct to anterior margin. Surface of pronotum finely punctured, somewhat shiny.

Head and pronotal color dark reddish brown. Elytral color piceus (lighter at base in some). Prosternum and mesosternum dark reddish-brown; mesosternum piceus.

Abdominal tergum II piceus. Terga III–IV flavate except for narrow piceus anterior margin. Terga V–VII completely piceus. Tergum VIII brown to reddish brown.

Sternum III completely pale. Sternum IV flavate except for piceus apico-lateral corners. Sternum V black to piceus except for flavate extreme basal margin in some. Sterna VI–VII completely black, piceus or dark reddish brown. Sternum VIII piceus (lighter at apex in some).

Protibia piceus in at least the proximal half. Mesotibia and metatibia piceus except for lighter apex. Profemur pale rufo-flavate to reddish-brown. Mesofemur piceus to dark reddish-brown. Metafemur piceus. Metatrochanter white.

Transverse impressions of terga III–IV with 6–8 moderately large pores arranged in a single row.

Secondary Sexual Characteristics: Absent.

Male: Parameres as in Figure 54; median lobe as in Figures 50, 51.

Female: Spermatheca not examined.

Type material: HOLOTYPE, male, here designated, with labels as follows: "PANAMÁ, Panamá Prov, 6.9 km S Gamboa, Old Plantation Rd., 09°05′N, 79°40′W, 3 June 1995, J. Ashe & R. Brooks #116, ex treefall litter," "HOLOTYPE, *Gansia taeniata* Ashe and Lingafelter, Desig. J. Ashe and S. Lingafelter, 1996." Holotype in the collection of the Snow Entomological Museum, University of Kansas, Lawrence, Kansas.

PARATYPES: 12. Same data as Holotype (3 KSEM); same locality, 27 May 1995, J. & A. Ashe #072 (1 KSEM); PANAMÁ: Galioa, VIII-1938, IX-X-1938, no collector (Bierig Collection), (8 FMNH).

Distribution: Known only from Panamá (Panamá Prov.) (Map 4).

Bionomics: Collected at low elevations (80 m) in treefall litter.

Etymology: From "taenia" (L., ribbon), referring to the ribbon-like band of flavate color at the base of the abdomen (terga III–IV).

Comments: *G. taeniata* is easily recognized by its distinctive color pattern: dark reddish-brown head and pronotum, piceus elytra, and piceus abdomen with the basal two terga (terga III–IV) flavate with a piceus anterior margin; as well as by its distinctive aedeagus (Figs. 50, 51) and parameres (Fig. 52). *Gansia taeniata* is unusual among Central American species because the paramere structure, with its short apical lobe and different arrangement of setae, is unlike that of any other known species in this fauna. However, specimens of *G. taeniata* have the same body form, mouthparts and other external characters as all other species of *Gansia.* We have also seen several species of *Gansia* from South America that have this paramere structure. Which of the paramere structures exhibited by various species of *Gansia* is plesiomorphic and which is apomorphic will require comparative and phylogenetic studies that are outside the bounds of this paper.

Gansia tergopunctata, n. sp.

(Figs. 17, 53–56; Map 4)

Description: (Fig. 17) length of elytra 0.44–0.50 mm. Width of head including eyes, 0.42–0.45 mm. Ratio of length to width of pronotum 0.79–0.92.

Head without distinct impression. Pronotum with variable impression which attains anterior margin in most. Surface of pronotum finely punctured, somewhat shiny.

Head and pronotal color rufo-flavate. Elytral color rufo-flavate to reddish brown. Prosternum and mesosternum rufo-flavate; metasternum dark reddish brown to piceus.

Tergum II reddish-brown. Terga III–IV uniformly rufo-flavate or with extreme posterior margin slightly piceus in some. Tergum V with basal half rufo-flavate and posterior half piceus; piceus band strongly arcuate medially. Tergum VI completely piceus. Terga VII–VIII rufo-flavate or light reddish-brown (tergum VII with brownish base in some).

Sterna III–IV rufo-flavate except for piceus postero-lateral corners. Sternum V

rufo-flavate except for extreme posterior margin which is piceus. Sternum VI completely piceus to dark reddish brown. Sterna VII-VIII completely rufo-flavate.

Protibia, mesotibia, and metatibia mostly pale rufo-flavate or light reddish brown except for darker, sometimes piceus basal fourth to third. Profemur, mesofemur and metafemur mostly rufo-flavate except for darker piceus apical fourth to third. Metatrochanter pale orange.

Transverse impressions of abdominal terga III–V each with 2 irregular rows of 12–14 moderate sized, closely arranged punctures.

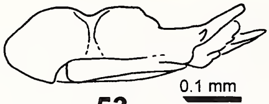
Secondary Sexual Characteristics: Absent.

Male: Parameres as in Figure 56; median lobe as in Figures 53, 54.

Female: Spermatheca as in Figure 55.

Type Material: HOLOTYPE, male, here designated, with labels as follows: "PANAMÁ, Chiriquí Prov., La Fortuna, "Cont. Divide Trail," 08°46′N, 82°12′W, 1,100 m, 23 May 1995, J. & A. Ashe #048, ex decaying slash," "HOLOTYPE, *Gansia tergopunctata* Ashe and Lingafelter, Desig. J. Ashe and S. Lingafelter, 1996." Holotype in the collection of the Snow Entomological Museum, University of Kansas, Lawrence, Kansas.

PARATYPES: 75. Same data as holotype (1 KSEM); PANAMÁ: Bocas del Toro, Fortuna/Chiriquí Grande Rd. 8°47′N 82°12′W, 1050 m, 12–14 July 1987, D. M. Olson #523, premontane rain forest, sifting litter (17 FMNH); same locality and collector, 800 m, 14–16 July 1987 (1 FMNH); same locality, collector and habitat, Sendero Divsa, 1290 m, 9–11 July 1987, (2 FMNH); same locality, collector and habitat, 500 m, 16–18 July 1987 (4 FMNH); Cerro Pata de Macho trail, W of Cerro Horqueta near Boquete, 8°47′N, 82°23′W, 2,020 m, D. M. Olson #751, lower montane rain forest, sifting litter (3 FMNH); Qda. Alicia cloud for., 1,500 m, 4 June 1980, FMHD #80-1, fl. litter on slopes, J. Wagner (1 FMNH). Chiriquí Prov., La Fortuna, "Hydro. Trail", 08°42′N, 82°14′W, 1,150 m, 22 May 1995, J. & A. Ashe #034, ex treefall litter (1 KSEM); La Fortuna, "Cont. Divide Trail," 08°46′N, 82°12′W, 1,150 m, 9 June 1995, J. Ashe, R. Brooks #151, ex slash (5 KSEM); same locality, and collectors, 23 May–9 June 1995, #157, ex flight intercept trap (1 KSEM); same locality and collectors, 9 June 1995; # 159, ex rotting elephant ear leaves (2 KSEM); same locality and collectors, 9–12 June 1995, #185, ex flight intercept trap (1 KSEM); La Fortuna, El Vivero, 14–18 June 1994, A. Gillogly, ex flight intercept trap (1 KSEM); 5.4 km NE Boquete, 08°48′N, 82°26′W, 1,520 m, 19 June 1995, J. Ashe, R. Brooks #249, ex treefall litter (1 KSEM); Cerro Colorado cloud forest, 18 January 1981, FMHD #81-21, W. Suter, litter on bulldozed slope along hwy. 17, under fern (1 FMNH); Cocle Prov., El Cope, 720 m, 19–20 Nov. 1994, D. Windsor, C. Edmonds, ex. flight intercept trap (1 KSEM); El Valle, 2,400–2,600 m, 22 February 1959, H. S. Dybas, ex damp floor litter in ravine (1 FMNH). Panamá Prov., Cerro Jefe, 13 July 1978, Windsor, ex sifting leaf litter elfen cloud forest (1 KSEM). COSTA RICA: La Estrella, 24 October 1941, no collector (Bierig collection) (7 FMNH); Corcovado, 8 June 1940, no collector (Bierig collection) (2 FMNH); Tapantí, 15 March 1940, no collector (Bierig collection) (5 FMNH); Guanacaste Prov., Patilla Biol. Sta. 10°58′N, 85°26′W, 650 m, 2 May 1995, J. Ashe, ex treefall litter (5 KSEM); same locality, March 1991, C. Moraga (4 INBI); OTS sta., 0.5 km SW Las Cruces, 4,700 ft, 15 March 1973, J. Wagner & J. Kethley, FMHD #73-306, 73CRIII-15d, Lafila. leaf litter (2 FMNH); same locality and collectors,



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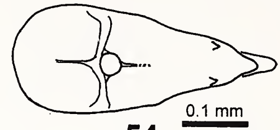

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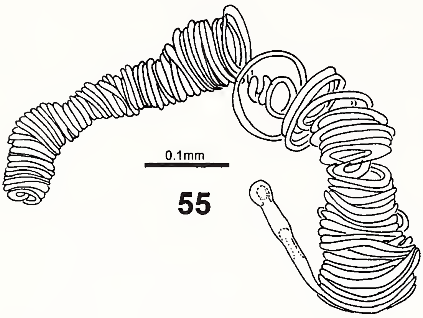

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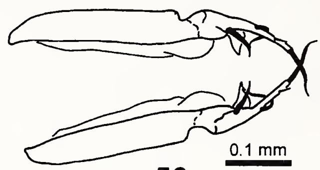

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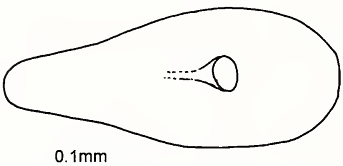

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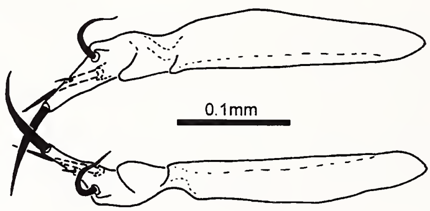

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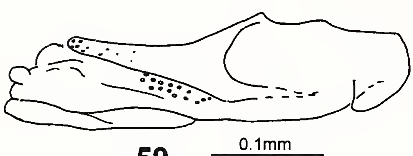

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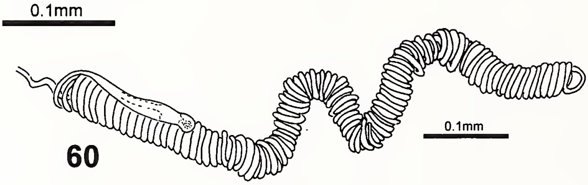

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Figs. 53–56. *Gansia tergopunctata* n. sp. 53, median lobe of aedeagus, lateral aspect; 54, median lobe of aedeagus, dorsal aspect; 55, spermatheca; 56, parameres of aedeagus, ventral aspect.

Figs. 57–60. *Gansia unizonata* n. sp. 57, median lobe of aedeagus, dorsal aspect; 58, parameres of aedeagus, ventral aspect; 59, median lobe of aedeagus, lateral aspect; 60, spermatheca.

4,000 ft, 16 March 1973, ex conc. floor litter on slope above stream (1 FMNH); Cartago Prov., 19.3 km NE San Jose, 1,100 m, 17 May 1993, J. & A. Ashe #017, ex treefall litter (1 KSEM); San Jose Prov., La Hondura, Rio Claro, 10°3′N, 83°58′W, 1,150 m, 5 April 1973, J. Wagner & J. Kethley, ex berl. stream bed leaf litter (1 FMNH); Turrialba Prov., Grano de Oro, 1,120 m, Dec. 1993, ex. malaise trap (1 KSEM); Sta. Cruz, 1,300 m, 18 July 1943, no collector (Bierig collection) (1 FMNH).

Distribution: Occurring in Panamá (Chiriquí Prov.) and Costa Rica (Guanacaste, Turrialba, and Cartago Prov.) (Map 4).

Bionomics: Collected from 650–1,520 m in a range of habitats including treefall litter, slash, flight intercept traps, rotting elephant ear leaves, leaf litter and malaise trap.

Etymology: Name refers to the relatively large number of punctures in the transverse impression of abdominal terga III-V on members of this species.

Comments: Most specimens of *G. tergopunctata* are easily recognized by the combination of: large number of punctures in the transverse impression of abdominal terga III-V (12–14 punctures in each), arranged in 2 irregular rows; and, the flavate color of the apical abdominal segments (terga VII–VIII) (Fig. 17). In Central America, only *G. bipictanota* has a similar double row of punctures in the transverse impressions of these terga, and specimens of this species usually have bicolored pronota and dark abdominal apices. However, darker specimens of *G. tergopunctata* may have the base of segment VII darkened, and some light or teneral specimens of *G. bipictanota* have abdominal segment VIII lighter brown. In these instances, these two species are difficult to separate based on external characteristics, and aedeagi must be examined to distinguish between them. Because some specimens of these two species are very similar in external features, it seems possible that they actually represent color forms of the same species; however, the aedeagi of the two species are quite different, and the males of *G. bipictanota* have abdominal sternum VIII modified as noted below while males of *G. tergopunctata* do not have obvious secondary sexual characteristics.

Gansia tibialis Sharp
(Map 1)

Description: Length of elytra 0.51 mm. Width of head including eyes, 0.47 mm. Ratio of length to width of pronotum 0.76.

Head without distinct medial impression. Pronotum with shallow impression not attaining anterior margin. Surface of pronotum coarsely punctured, somewhat opaque.

Head, pronotum and elytra rufo-flavate (Sharp, 1883, refers to this color as "testaceus"). Mesosternum and metasternum rufo-flavate.

Abdominal tergum II rufo-flavate. Terga III–IV uniformly rufo-flavate. Tergum V rufo-flavate except for piceus posterior margin, piceus color moderately arcuate medially. Tergum VI piceus except for rufo-flavate antero-lateral corners. Terga VII-VIII rufo-flavate.

Sterna III–IV rufo-flavate. Sterna V–VI rufo-flavate except for extreme posterior margin which is piceus. Sterna VII–VIII completely rufo-flavate.

Protibia rufo-flavate; mesotibia and metatibia rufo-flavate in apical half and dark reddish-brown in basal half (dark color more extensive on metatibia). Profemur and mesofemur rufo-flavate; metafemur rufo-flavate with slightly darker apex.

Transverse impressions of abdominal tergum III–V with 6–8 punctures in a single row, punctures close, separated by faintly developed longitudinal ridges.

Secondary Sexual Characteristics: Not examined.

Male: Not examined.

Female: Not examined.

Type Material: LECTOTYPE, here designated, with labels as follows: "*Gansia tibialis,* Type, D.S., Cerro Zunil, 4–5,000 ft, Champion," "Cerro Zunil, Guatemala, Champion," "B.C.A. Col. I. 2., *Gansia tibilais* Sharp," "Sharp Coll. 1905–313," "Lectotype, *Gansia tibialis* Sharp, Desig. J. S. Ashe and S. A. Lingafelter, 1996." In the collection of the Natural History Museum, London.

Distribution: Known only from the type specimen collected at 4,000–5,000 ft, Cerro Zunil, in Guatemala.

Bionomics: Not known.

Comments: *G. tibialis* is known only from the type specimen. Because of lack of secondary sexual characters in many *Gansia,* and the fact that sternum IX of males is frequently withdrawn into the apex of the abdomen, we were not able to determine the sex of the type specimen. Because there are no other known specimens of this species, and because *G. tibialis* could be easily distinguished from all other known species of *Gansia* based on external characteristics, we elected not to dissect this specimen. Consequently, some descriptive features are not available for *G. tibialis.* However, *G. tibialis* can be easily distinguished from all other known species by the characters in the key. *G. tibialis* is very similar to *G. flavata* in color pattern (see Fig. 14), but it can be easily distinguished from this latter species by the larger size and greater number of punctures in the transverse impressions of abdominal terga III–V of *G. tibialis.*

Gansia unizonata, n. sp.
(Figs. 18, 57–60; Map 2)

Description: (Fig. 18) Length of elytra 0.43–0.47 mm. Width of head including eyes, 0.45–0.47 mm. Ratio of length to width of pronotum 0.94–1.02.

Head without distinct medial impression. Pronotum with shallow impression restricted to basal half. Surface of pronotum finely punctured, somewhat shiny.

Head and pronotal color piceus to dark reddish brown. Elytral color piceus (lighter at base in some). Prosternum, mesosternum and metasternum black to piceus.

Abdominal tergum II piceus. Tergum III uniformly flavate. Tergum IV black or piceus except for extreme basal margin which is flavate in some. Terga V–VIII completely black or piceus.

Sternum III completely flavate. Sterna IV–V black or piceus except for flavate extreme basal margin. Sterna VI–VII completely black, piceus or dark reddish brown. Sternum VIII variable in color, from piceus to brown.

Protibia, mesotibia, and metatibia pale rufo-flavate. Profemur reddish-brown to piceus. Mesofemur and metafemur piceus. Metatrochanter white.

Transverse impressions of terga III–IV with 6–8 moderately large punctures arranged in a single row, punctures close, separated by faint longitudinal ridges.
Secondary Sexual Characteristics: Absent.
Male: Parameres as in Figure 58; median lobe as in Figures 57, 59.
Female: Spermatheca as in Figure 60.
Type material: HOLOTYPE, male, here designated, with labels as follows: "PANAMÁ, Chiriquí Prov., 20.4 km N San Felix, 08°22′N, 81°46′W, 950 m, 8 June 1995, J. Ashe, R. Brooks #145, ex roadside slash," "HOLOTYPE, *Gansia unizonata* Ashe and Lingafelter, Desig. J. Ashe and S. Lingafelter, 1996." Holotype in the collection of the Snow Entomological Museum, University of Kansas, Lawrence, Kansas.
PARATYPES: 18. Same data as holotype (7 KSEM); same except #144 (2 KSEM); 20 km N Gualaca, Finca La Suiza, 08°39′N, 82°12′W, 1350 m, 10 June 1995, J. Ashe and R. Brooks #170, ex slash (1 KSEM); 10.5 km NE Caldera, 08°42′N, 82°19′W, 340 m, 24 May 1995, J. & A. Ashe #058, ex treefall litter (6 KSEM). COSTA RICA: Hamburg Farm, 2 July 1925, 29 March 1935, Nevermann (2 FMNH).
Distribution: Known only from Panamá (Chiriquí Prov.) and Hamburg Farm in Costa Rica (Map 2).
Bionomics: Collected at elevations of 340–950 m in slash and treefall litter.
Etymology: From "unus" (L., one) and "zona" (L., belt or girdle), referring to the single band of light flavate color around the base of the abdomen on specimens of this species.
Comments: *G. unizonata* is one of the most easily recognized species in Central America. The uniformly black or piceus body with the flavate basal segment of the abdomen (Fig. 18) is unique among known Central American *Gansia.*

ACKNOWLEDGMENTS

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THREE NEW SPECIES OF *CAENAUGOCHLORA* (*CTENAUGOCHLORA*) (HYMENOPTERA: HALICTIDAE)

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Abstract.—Three new species of the augochlorine genus *Caenaugochlora* subgenus *Ctenaugochlora* are described: *Caenaugochlora* (*Ctenaugochlora*) *donnae* n.sp. and *C.* (*C.*) *beethoveni* n.sp. both from Costa Rica, and *C.* (*C.*) *algeri* n.sp. from Panama. The subgenus was previously only known from the type species, *C.* (*C.*) *perpectinata* (Michener) from Panama. A key is provided for the identification of the currently recognized species.

Key Words: Augochlorini, *Caenaugochlora, Ctenaugochlora,* Halictidae, new species.

The genus *Caenaugochlora* is a wide ranging (Ecuador to Mexico) group of halictid bees from the New World tribe Augochlorini. Two subgenera are recognized within the genus—the nominate subgenus with 13 described species; and the subgenus *Ctenaugochlora* containing only the type species, *Caenaugochlora perpectinata* (Michener) (Moure and Hurd, 1987). A third subgenus will be described in a forthcoming paper. The biology of one species, *C. costaricensis* (Friese), has been studied by Michener and Kerfoot (1967: as *Pseudaugochloropsis costaricensis*). This species nests in the ground, constructing a short turret around the nest entrance. The nests are composed of a simple tunnel leading to a cell chamber, usually with a short terminal burrow. The species is likely to be semisocial.

During my systematic studies of the genera and subgenera of the augochlorine bees, I have come across additional species of some groups previously represented by only a single species, one of these being *Ctenaugochlora. Ctenaugochlora* can most readily be separated from the nominate subgenus by the peculiar pectination of the inner hind tibial spur, with over 10 long teeth closely packed together (Fig. 2), and by the lack of long eye hairs. Herein I provide descriptions of three new species for this subgenus in order to have their names available for upcoming studies of relationships within the tribe. All measurements were made with an ocular micrometer on a WILD-M5a microscope.

Caenaugochlora (Ctenaugochlora) beethoveni, new species

Description: Female (male unknown); total body length 8.72 mm; forewing length 6.56 mm. Head as long as wide. Width of gena roughly equal to compound eye in profile. Angle of epistomal sulcus orthogonal (measured between lateral clypeo-genal sulcus and dorsal clypeo-genal sulcus with angle opening towards compound eye: *sensu* Eickwort, 1969). Distal half of clypeus extending beyond lower margin of compound eyes; clypeus and supraclypeal area very slightly rounded and only very slightly protuberant in profile, face relatively flat; supraclypeal area about as long as wide. Mandible short, monodentate and blunt; subapical tooth very weakly defined.

Labral basal elevation U-shaped and slightly bilobed due to medial impression; distal extension narrowly triangular. Frontal line carinate between antennae, becoming a weak impression half way between antenna and median ocellus. Scape length 1 mm; pedicel longer than flagellomere I; flagellomere I roughly as long as wide; flagellomeres II, III, and IV each as long as wide and longer than I; flagellomeres V, VI, and VII each as long as wide and longer than II, III, or IV; remaining flagellomeres progressively longer than each other; distal flagellomere longer than wide (length 0.36 mm; width 0.22 mm). Ocelli normal, not enlarged; median ocellus to lateral ocellus 0.08 mm; between lateral ocelli 0.22 mm; lateral ocellus to compound eye 0.24 mm. Compound eyes strongly emarginate, weakly convergent below; with short eye hairs. Vertex short. Preoccipital ridge carinate. Proboscidial fossa length 1.06 mm; width 0.38 mm. Hypostomal ridge carinate, not projecting beyond posterior margin of head, anterior angle rounded. Mouthparts normal, not greatly elongated or narrowed. Pronotal lateral angle slightly obtuse; lateral ridge sharply angled; dorsal ridge carinate. Scutum broadly rounded anteriorly, with slight median dimple; mesoscutal lip rounded, slightly projecting over pronotum; median and parapsidal lines weakly impressed. Tegula rounded; intertegular distance 1.58 mm. Scutellum flat, one and a half times longer than metanotum. Subpleural signum slightly protuberant, blunt. Propodeal triangle slightly shorter than scutellum; propodeal dorsal ridge rounded, lateral ridge carinate. Wing veins brown; basal vein distad of cu-v crossvein (offset by four times the width of a vein); 1r-m confluent with 1m-cu; 2r-m distad of 2m-cu (offset by two times the width of a vein). First submarginal cell slightly wider than second and third combined (measured along a median axis); second submarginal cell only slightly narrower anteriorly than posteriorly; anterior border of second submarginal cell along Rs roughly equal to anterior border of third submarginal cell; marginal cell apex truncate and feebly appendiculate; wings hyaline. Hind tibia inner surface slightly concave and broad. Basitibial plate narrowly rounded, not defined anteriorly, weakly defined posteriorly. Inner hind tibial spur pectinate, all teeth long and closely packed, 13 teeth (not including apex as a tooth). Metasoma unmodified.

Mandible black with red-brown apex. Head entirely black, not shining. Clypeus finely coriaceous (appearing leathery) with scattered weak punctures; supraclypeal area finely granular; remainder of face with small close punctures; punctures separated by less than puncture width; integument otherwise finely granular. Scape black, basal tip with some light brown coloration; remainder of antenna dark brown. Gena and postgena costate. Pronotum finely imbricate, dark brown and polished. Mesosoma, except pronotum, black. Scutum closely punctate; punctures separated by less than puncture width; medially finely granular. Tegula dark brown with light brown, semi-translucent outer border; surface coriaceous. Scutellum punctate; integument between punctures granular. Metanotum impunctate and granular. Propleuron coriaceous. Pre-episternum rugose. Hypo-epimeral area costate; mesepisternum costate anteriorly becoming coriaceous on posterior two-thirds. Metepisternum costate dorsally, coriaceous basally. Propodeal triangle with strong diverging striae, radiating from basal margin; surface between striae coriaceous. Propodeal lateral surface coriaceous. Legs entirely dark brown, except foretarsi light brown; surfaces finely imbricate. Inner surface of hind tibia smooth and shining. All terga dark red-brown

with finely imbricate surfaces; anterior half of first tergum smooth. Sterna dark brown and imbricate.

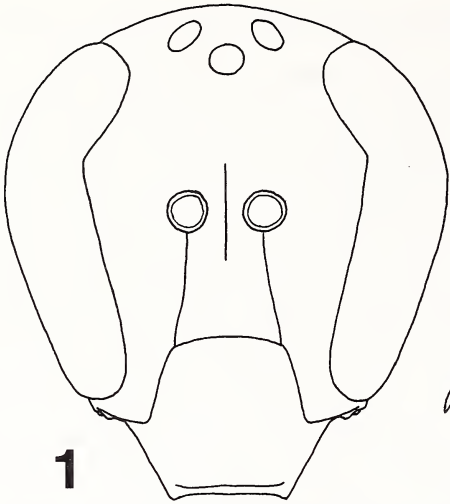
Face with widely scattered, moderately long, dark hairs, some with very short branches; few short, pale hairs along lower inner margin of compound eye. Gena with moderately long pale, branched hairs; such hairs more widely separated on postgena. Pronotal dorsal surface without hairs, laterally with extremely short, simple, silvery hairs. Scutum with widely scattered short, dark hairs that become longer and branched along anterolateral margins. Tegula with short, suberect hairs on anterior half; hairs with a few short branches. Hairs of scutellum like those of central disc of scutum. Hairs of metanotum longer and branched. Pleura with widely scattered simple hairs. Propodeal triangle without hairs; propodeal lateral surface with long, plumose hairs; posterior surface with extremely short, pale hairs and a few longer, branched hairs. Procoxa with simple hairs; trochanter and femur posteriorly with simple hairs, sometimes with 1–3 short branches; outer surface of tibia with short, stiff, simple hairs; hairs black basally becoming light brown or white apically; tarsi with long, stiff, simple hairs on outer surfaces, same color pattern as those of tibia. Pubescence of middle legs similar to that of fore legs. Hind trochanter and femur with scopa formed of long, plumose hairs; outer posterior surface of tibia with moderate, simple, black hairs; hairs of anterior surface with several branches; inner surface of tibia lacking hairs; basitarsal outer surface with black hairs, posterior margin with pale hairs; tarsi II and III with black hairs; remainder of tarsus with brown hairs. Anterior half of tergum I with moderately long, simple hairs. Posterior half of tergum I and entirety of remaining terga with more widely scattered, shorter, simple hairs that become slightly longer along lateral margins. Sterna with long, simple hairs; hairs sometimes with a few branches.

Holotype: Female, Costa Rica, Puntarenas Prov., Monteverde, 26 June 1981, S. Knapp, Nr. 0047. Deposited in the Cornell University Insect Collection.

Etymology: This species is named in honor of the German composer, Ludwig van Beethoven (1770–1827). A lovely personal account of the Maestro's life is given by Breuning (1874).

Caenaugochlora (Ctenaugochlora) donnae, new species
Fig. 1

Description: As in *C. beethoveni,* except as follows: Female (male unknown); total body length 9.48 mm; forewing length 7.36 mm. Head longer than wide (Fig. 1). Distal two-thirds of clypeus extending beyond lower margin of compound eyes; clypeus and supraclypeal area gently rounded and slightly protuberant in profile; supraclypeal area one and a half times longer than wide. Mandible slender; subapical tooth well defined. Frontal line carinate between antennae, becoming weakly impressed line shortly above level of antennal sockets. Scape length 1.1 mm; pedicel slightly shorter than flagellomere I; flagellomere I longer than wide; flagellomere II wider than long, not as long as I; flagellomeres III–VII each as long as wide, each longer than I; flagellomeres VIII and IX each as long as wide and longer than previous flagellomeres; distal flagellomere longer than wide. Median ocellus to lateral ocellus 0.08 mm; between lateral ocelli 0.24 mm; lateral ocellus to compound eye 0.24 mm. Proboscidial fossa length 1.32 mm; width 0.36 mm. Pronotal lateral



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Figs. 1–2. 1. *Caenaugochlora* (*Ctenaugochlora*) *donnae* n.sp., frontal aspect of head. 2. *Caenaugochlora* (*Ctenaugochlora*) *algeri* n.sp., inner hind tibial spur.

angle obtuse; lateral ridge rounded. Scutum broadly rounded anteriorly, with slight medial dimple; mesoscutal lip rounded, slightly projecting over pronotum; median and parapsidal lines fairly impressed. Intertegular distance 1.7 mm. Scutellum biconvex due to slight median depression, twice as long as metanotum. Subpleural signum strongly tuberculate, somewhat pointed. Propodeal triangle roughly equal to length of scutellum. Propodeal lateral ridge rounded. Wing veins dark brown. Inner hind tibial spur with 12 teeth (not including apex as a tooth).

Mandible black, somewhat red at apex, basally with metallic turquoise highlights. Face mostly brilliant metallic purple with turquoise highlights at antennal sockets and along eyes; sculpturing as in *C. beethoveni*, except punctures of supraclypeal area more dense about antennal sockets. Antenna brown. Gena and postgena metallic blue with purple highlights. Mesosoma entirely brilliant metallic blue with strong purple and turquoise highlights. Punctures of scutum separated by more than puncture width about median line, otherwise separated by less than puncture width. Tegula dark brown; anterolateral margin light brown and semi-translucent, with purple highlights. Legs red-brown with strong purple highlights. Metasoma red-brown with strong purple and turquoise highlights, appearing completely blue unless viewed under microscope.

Pubescence generally lighter than in *C. beethoveni*. Hairs of metanotum simple. Hairs on pleura, propodeum, and metasoma golden.

Holotype: Female, Costa Rica, San Jose Prov., Pan-Am Hwy, 14 rd mi N San Isidro de General, ca. 1,600 m, 20–23 June 1974, W. A. Harding and J.P. Donahue. Deposited in the Natural History of Los Angeles County.

Etymology: This species is named in loving honor of my mother, Donna G. Engel.

Caenaugochlora (Ctenaugochlora) algeri, new species
Fig. 2

Description: As for *C. beethoveni,* with the following modifications: Female (male unknown); total body length 8.78 mm; forewing length 6.24 mm. Head slightly wider than long. Clypeus and supraclypeal area gently rounded and slightly more protuberant than in *C. beethoveni.* Mandible slender, bidentate; subapical tooth strong making mandible appear tridentate. Scape length 1.02 mm. Median ocellus to lateral ocellus 0.1 mm; between lateral ocelli 0.28 mm; lateral ocellus to compound eye 0.28 mm. Proboscidial fossa length 0.96 mm; width 0.42 mm. Pronotal lateral angle obtuse. Intertegular distance 1.8 mm. Scutellum one and one-third times longer than metanotum. Propodeal triangle shorter than scutellum, but longer than metanotum. Propodeal dorsal ridge carinate. Wing veins brown basally, apically light brown; basal vein distad of cu-v crossvein (offset by two times the width of a vein). Anterior border of second submarginal cell along Rs longer than anterior border of third submarginal cell. Inner hind tibial spur with 14 teeth, not including apex as a tooth (Fig. 2).

Mandible black with reddish apex, basally with metallic blue-green highlights. Head black with blue-green highlights on clypeus and inner margins of eye; gena and postgena with similar highlights. Sculpturing as in *C. beethoveni,* except supraclypeal area punctate like remainder of face. Mesosoma black. Scutum punctate over entire surface, punctures essentially confluent. Tegula dark brown with blue-green highlights. Scutellum sculptured as on scutum. Metanotum rugose. Pleura rugose and punctate. Propodeal triangle as in *C. beethoveni,* except integument between striae smooth and shining. Propodeal lateral surface punctate. Legs black with a few blue-green highlights. Metasoma brilliant metallic gold, with strong metallic green highlights laterally and weaker metallic red-orange highlights apically. Anterior half of tergum I with strong punctures widely scattered. Remainder of tergum I, terga II and III all strongly punctate, punctures separated by puncture width or less. Terga IV and V with widely scattered, weak punctures, otherwise smooth and shining; metallic green coloration stronger than on previous terga. Sterna dark brown.

Pubescence as for *C. beethoveni,* except hairs of scutum more numerous, hairs on anterior half of tegula more dense, and a few long, black hairs on tergal lateral margins.

Holotype: Female, Panama, Panama Prov., Chepo, 6 km NE C rd, 24 November 1982, D. Roubik, Nr. 57. Deposited in the Cornell University Insect Collection.

Etymology: This species is named in loving honor of my father, Rev. Alger G. Engel.

KEY TO DESCRIBED SPECIES OF *CTENAUGOCHLORA*

1. Metasomal terga I–III closely punctured; punctures strong and separated by a puncture width or less. 2
   Metasomal terga I–III impunctate. 3
2. Propodeal dorsal ridge carinate; metasoma metallic gold; scape entirely black; wings hyaline. . . . . *algeri*
   Propodeal dorsal ridge rounded; metasoma black; scape mostly light brown; anterior portion of forewings darker than remainder of wing. . . . . *perpectinata*

3. Entire bee brilliant metallic blue; subpleural signum strongly tuberculate; head distinctly longer than wide; scutellum weakly biconvex due to median depression. . . . . *donnae*
   Body black; subpleural signum normal; head roughly as long as wide; scutellum flat, lacking a median depression. . . . . *beethoveni*

ACKNOWLEDGMENTS

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DESCRIPTION OF TWO NEW SPECIES OF *EOSENTOMON* FROM THE OUACHITA MOUNTAINS OF ARKANSAS WITH A KEY TO THE SPECIES WITH THE 6/4 SETAL PATTERN ON STERNA IX/X (PROTURA: EOSENTOMIDAE)

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Abstract.—Two new species of *Eosentomon, E. megatibiense* and *E. maryae,* are described from Village Creek Park and Hot Springs National Park, Arkansas. Both species display the 6/4 setal arrangement on sternites IX/X. A key is provided to separate the North American (north of Mexico) species of *Eosentomon* that exhibit this setal pattern.

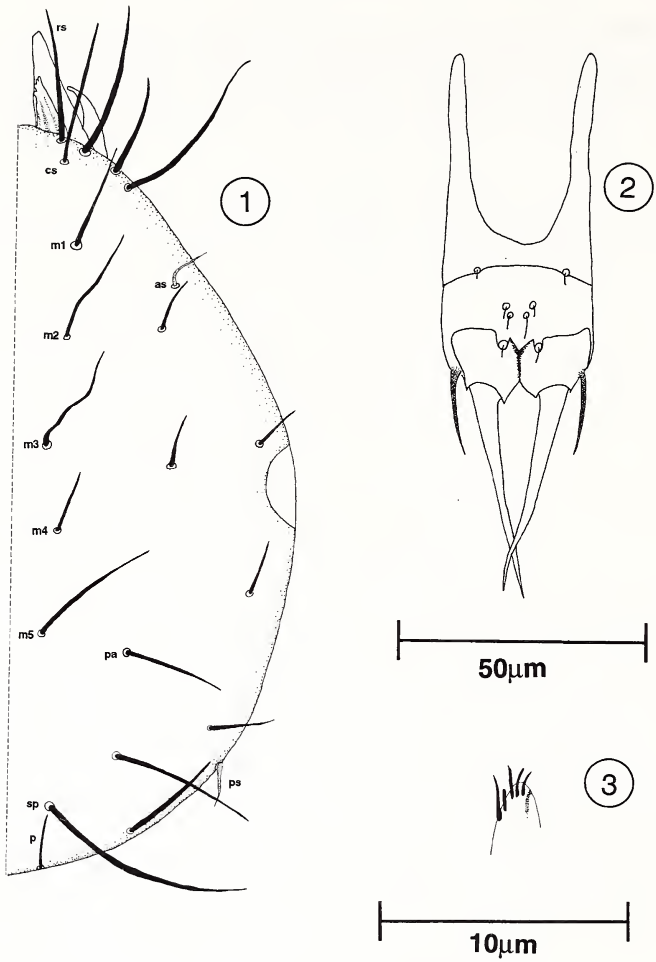
MATERIALS AND METHODS

The material examined included seventeen specimens of *Eosentomon megatibiense* and twenty specimens of *Eosentomon maryae.* All material was from the T. P. Copeland Protura slide collection, currently housed at the University of Arkansas. All measurements are in micrometers (μm) and were made with the JAVA Image Analysis System (Jandel Scientific) linked to a Nikon Optiphot 2 phase contrast microscope. The terminology used in species descriptions is consistent with Tipping and Allen (1994), Bernard (1990), Copeland (1962, 1964), and Tuxen (1964). Setal pattern designation conforms to Tuxen's system with the lowest Arabic numeral starting at the midline and progressing outward. Measurements of the head were made dorsally. Illustrations were made with the aid of a drawing tube attached to a Nikon Labophot 2 phase contrast microscope.

Eosentomon megatibiense, new species
Figs. 1–13

Body slightly sclerotized and pale yellow, with a mean length of 1,349 microns (1170–1480, N = 17).

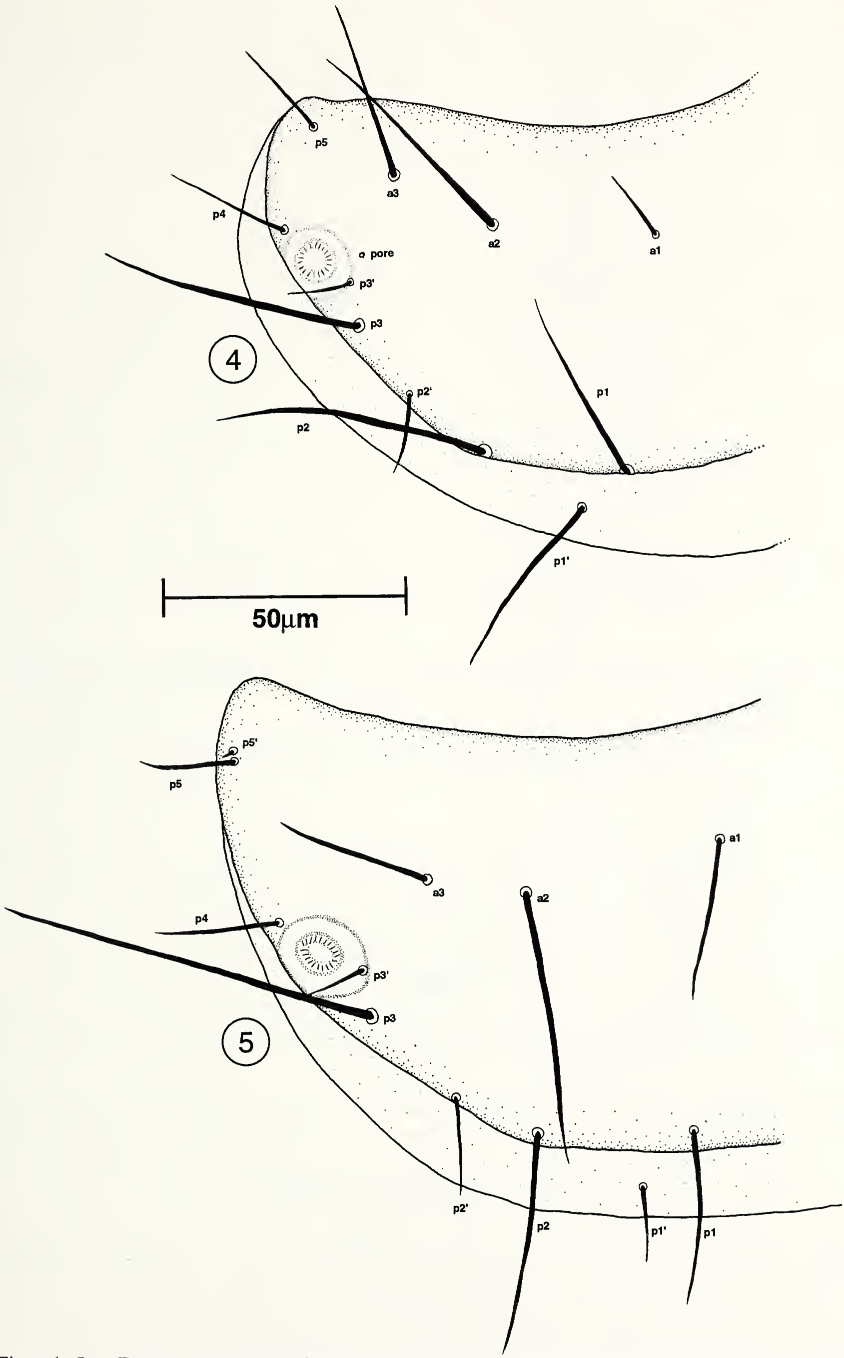
Head. Length of head (Fig. 1) without labrum, 135 μm (131–140, N = 17). Labrum medium, 14.5 μm (12.3–15.2, N = 17) without setae. LR = 9.8 (9.4–10.2, N = 17). Mandibles broad, straight, and striated, with four distinct apical teeth. Digits of galea (Fig. 3) well developed, inner, median, and outer digits rounded apically with a small projection between outer digit and exterior spine. Exterior spine straight, not reaching beyond apex of galea. Outer lobe of lacinia greatly curved at distal end. First pair of rostral setae (I) hair-like without modification. Rostral setae ratio (RSR) of I and III = 0.76. Pseudoculus oval, with no visible markings, PR = 12.5 (11.7–13.8, N = 17). Cephalic setae *aa* absent, *pa* present and long. Anterior sensillum *as* present. Seta *sp* very long, 3.1 times the length of seta *p* (2.8–3.6, N = 17). Clypeal apodemes not distinct. Labial arm, cardo, and maxillary ramus of tentorium very distinct. Sag-



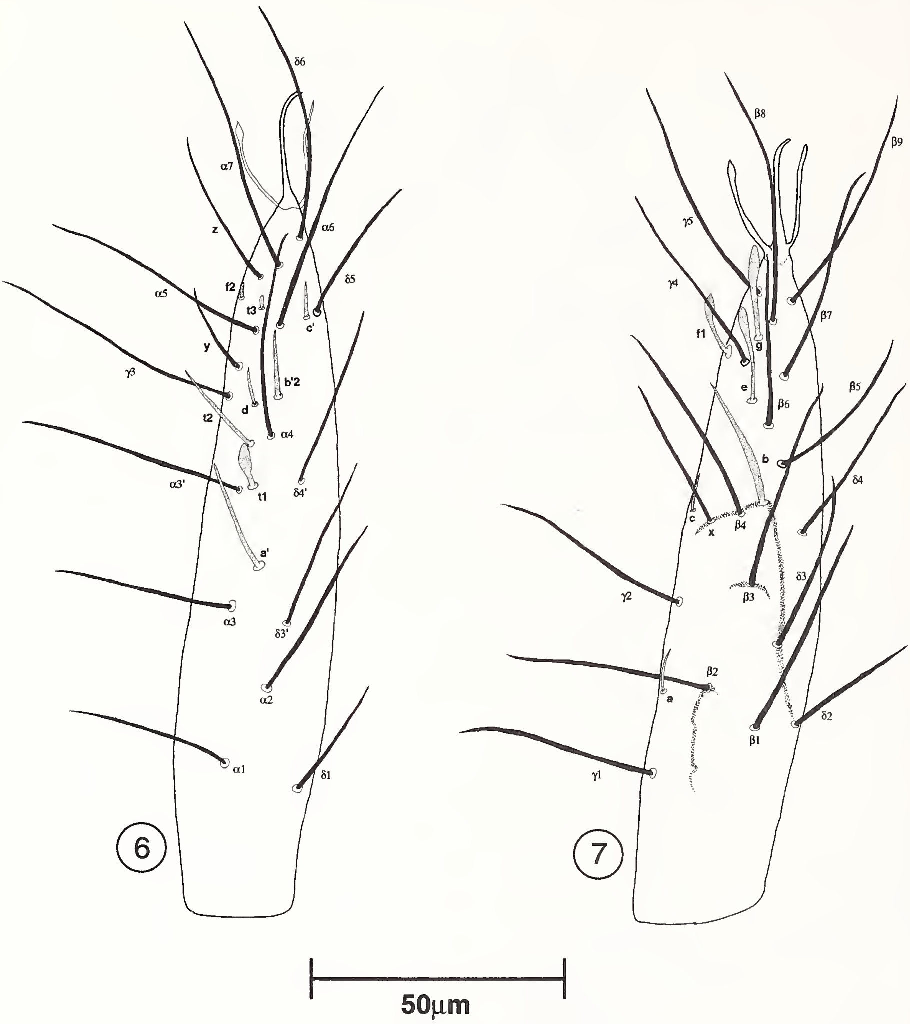
Figs. 1–3. *Eosentomon megatibiense:* 1, Head, dorsal view; 2, Galea; 3, Male squama genitalis; (50 µm scale refers to Figs. 1 and 3; 10 µm scale refers to Fig. 2.)

ittal keel or postoccipital apodeme as described by Copeland (1962) and Tuxen (1964) visible but not distinct.

Thorax. Dorsum of pronotum with four posterior setae. Seta *p1* 1.3 times longer than *p2*. (1.28–1.35, N = 17). On mesonotum, (Fig. 4) setae *p1* slightly longer than *p1'* in length. Seta *p2* 4.2 times the length of *p2'* (4.08–4.29, N = 17). Seta *p3* 5.1 times the length of *p3'* (4.8–5.4, N = 17). Seta *p3'* long as width of mesothoracic spiracle. Spiracular gland pore present. Seta *a2* long, subequal to *p2*. Setal pattern on posterior and lateral margin of metanotum (Fig. 5) same as mesonotum except *p3* is 4.1 times longer than *p3'* (3.7–4.3, N = 17). Seta *p3* 5.2 times longer than *p3'* (4.9–5.4, N = 17). Seta *a2* long, subequal to *p3*. Seta *p5'* present and gemmate.



Figs. 4–5. *Eosentomon megatibiense:* 4, Postero-lateral margin of the mesonotum; 5, Postero-lateral margin of the metanotum.



Figs. 6–7. *Eosentomon megatibiense:* 6, Foretarsus, dorsal view; 7, Fortarsus, ventral view.

Tarsi. Foretarsi (Figs. 6, 7) without claw 117.8 µm (111–122, N = 17). Length of claw 21.7 µm (21.0–22.5, N = 17); TR = 5.4. Empodium of foretarsi medium, EU = 0.73. Meso and metatarsi empodia short. EU II = 0.07 (0.06–0.09, N = 1). EU III = 0.08 (0.06–0.08, N = 17). Foretarsal sensilla *a* and *c* linear; sensillum *b′1* absent; sensilla *a′, b, b′2, t2,* linear, pointed with same length and shape; sensillum *f1* pointed spatulate; sensillum *a′* medium, not reaching base of *t2*; sensillum *c′* short, pointed, oblong; sensilla *d, f2,* and *t3* short, more oblong than oval; sensilla *e* and *g* thinly pointed spatulate clubs similar in size; sensillum *t1* large, inserted close to *α3′* with shank one half the length of club. BS = 1.42 (1.35–1.47, N = 17).

Table 1. Abdominal chaetotaxy of *Eosentomon megatibiense* n. sp.

Abd	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Tergum	$\frac{4}{12}$[a]	$\frac{10}{16}$	$\frac{10}{16}$	$\frac{10}{16}$	$\frac{8}{16}$	$\frac{8}{16}$	$\frac{8}{16}$	$\frac{6}{9}$	8	8	8	9
Sternum	$\frac{4}{4}$	$\frac{6}{4}$	$\frac{6}{4}$	$\frac{6}{10}$	$\frac{6}{10}$	$\frac{6}{10}$	$\frac{6}{10}$	$\frac{2}{7}$	6	4	8	12

[a] Two primary, two accessory, and two microchaetae on each side.

Abdomen. Abdominal chaetotaxy given in Table 1 with pleural setae included with tergal setae. Posterior row of tergum I (Fig. 8) with two primary, two accessory, and two microchaetae. First microchaeta long gemmate. Second microchaeta described by Bernard (1990) and Copeland (1962), located near each posterior corner, not easily distinguished. Tergites I–V (Fig. 9) have primary setae distinctly longer than associated accessory setae. First pair of accessory setae on tergum VII (Fig. 12) one-tenth length of corresponding primaries. Tergum VIII (Fig. 10) with *p2′* pointed. Tergal gland easily distinguished. Sternum VIII possessing two anterior and seven posterior setae. Sterna IX and X (Fig. 11) with six and four setae respectively. Precosta of tergites with slightly incised edge as described by Bernard (1990).

Genitalia. Female squama (Fig. 13) basal apodemes curving outward; *processus sternales* well sclerotized with caput process shaped like a "robin's head" in profile. Posterior valves long, consisting of two distinct parts. Male genitalia (Fig. 2) not unusual.

Holotype. Female. Slide AK 49-47: Village Creek Park, Arkansas, August 23, 1977. T. Copeland. Type Deposition: American Museum of Natural History (USNM), New York, USA.

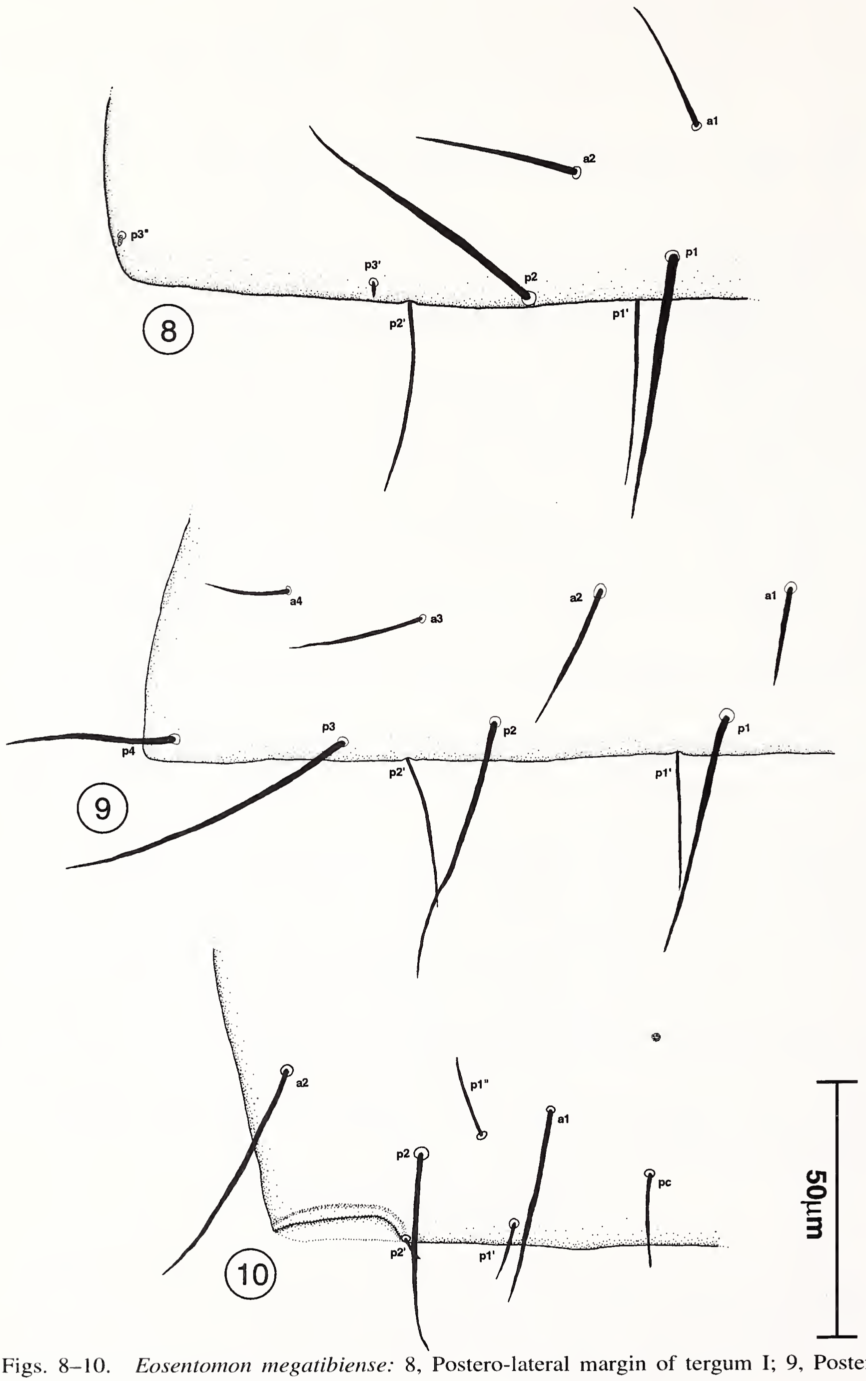
Paratypes. 12 females, 4 males. Village Creek Park, Arkansas, August 23, 1977. T. Copeland. Type Deposition: University of Arkansas Arthropod Collection, Fayetteville, Arkansas, USA.

Etymology. This species is named after the enlarged prothoracic tibia.

Discussion. *Eosentomon megatibiense* displays the 6/4 setal arrangement on sternites IX/X found in *E. quapawense* Tipping and Allen (in press). A key for determination of the members of this group is found at the end of this publication. *Eosentomon megatibiense* appears similar to *E. montanum* (Copeland 1964). Similarities include: same abdominal tergal chaetal patterns, broad straight mandibles, and similar RSR. Differences include: the 6/4 setal arrangement on the IX/X sterna, primary abdominal setae distinctly longer than associated accessories, and sensillum *s* on pretarsus with distinct club. *Eosentomon montanum* exhibits: six setae on both IX/X sterna, primary and accessory abdominal setae subequal in length, and pretarsal sensillum *s* with club extremely small or absent.

Eosentomon maryae, new species
Figs. 14–26

Sample consists of thirty-eight maturus juniors, two males, and one female. Measurements with MJ preceding are derived from the maturus juniors. Only the twenty best MJ specimens were used in determining measurements and ratios. Body pale with little sclerotization; mean length of adults 1,137 μm (1,085–1,152, N = 3); MJ = 897 μm (569–1,074, N = 20).



Figs. 8–10. *Eosentomon megatibiense:* 8, Postero-lateral margin of tergum I; 9, Postero-lateral margin of tergum II; 10, Postero-lateral margin of tergum VIII.

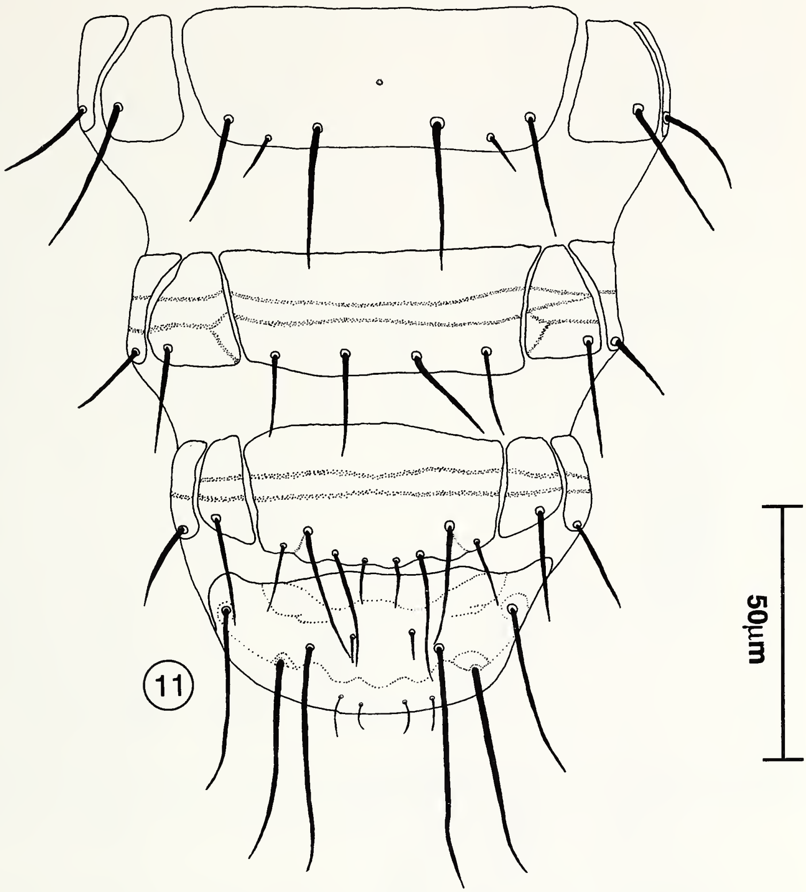
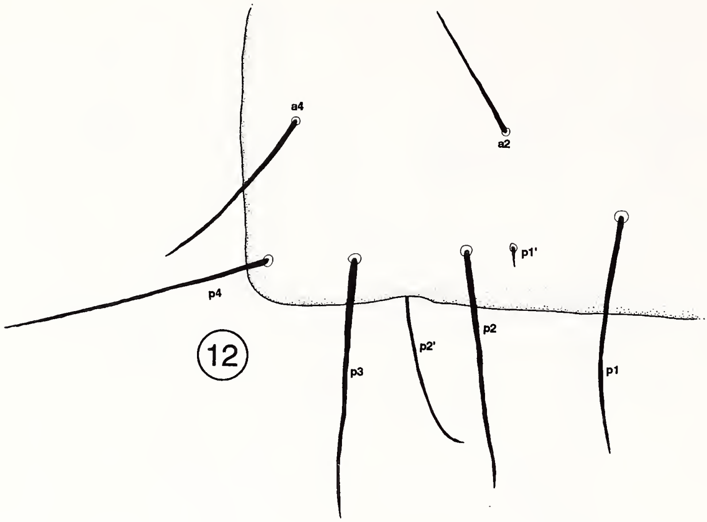
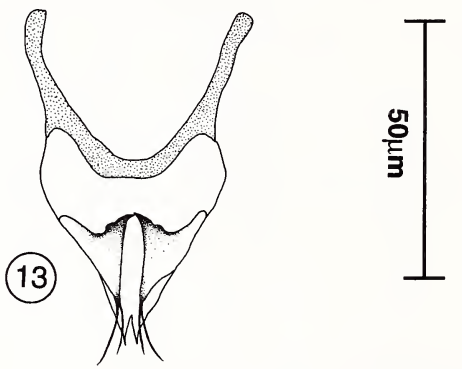


Fig. 11. *Eosentomon megatibiense:* 11, Sterna IX–XII.

Head. Head oblong (Fig. 14). Length of head excluding labrum 108.5 µm (98.5–122.0, N = 3); MJ = 97.4 µm (91.2–105.4, N = 20). Labrum short 8.6 µm (7.6–9.0, N = 3); MJ = 9.7 µm (9.1–10.3, N = 20) with two setae reaching apex of labium. LR = 12.6 (11.7–13.2 N = 3); MJ = 10.0 (9.5–10.9). Mandibles short, curved distally with 2 distinct apical teeth. Digits of galea (Fig. 15) well developed. Inner, median and outer digits rounded apically. Exterior spine long, reaching beyond apex of galea. Outer lobe of lacinia slightly curved distally. First pair of rostral setae (I) slightly inflated along basal third. RSR of both adult and maturus juniors = 0.70. Pseudoculus roughly circular with slight striations in adult, no visible markings in maturus juniors. PR = 11.5 (10.8–11.8, N = 3); MJ = 13.9 (13.3–14.4, N = 20). Cephalic seta *aa* present. Cephalic sensilla *ps* and *as* distinct. Seta *sp* 1.7 times length of seta *p* (1.4–1.9, N = 3); MJ = 1.8 (1.4–2.1, N = 20). Cardo and maxillary ramus of tentorium distinct in the adults, not visible in maturus juniors.

Thorax. Dorsum of pronotum with four posterior setae. Seta *p1* 1.2 times longer

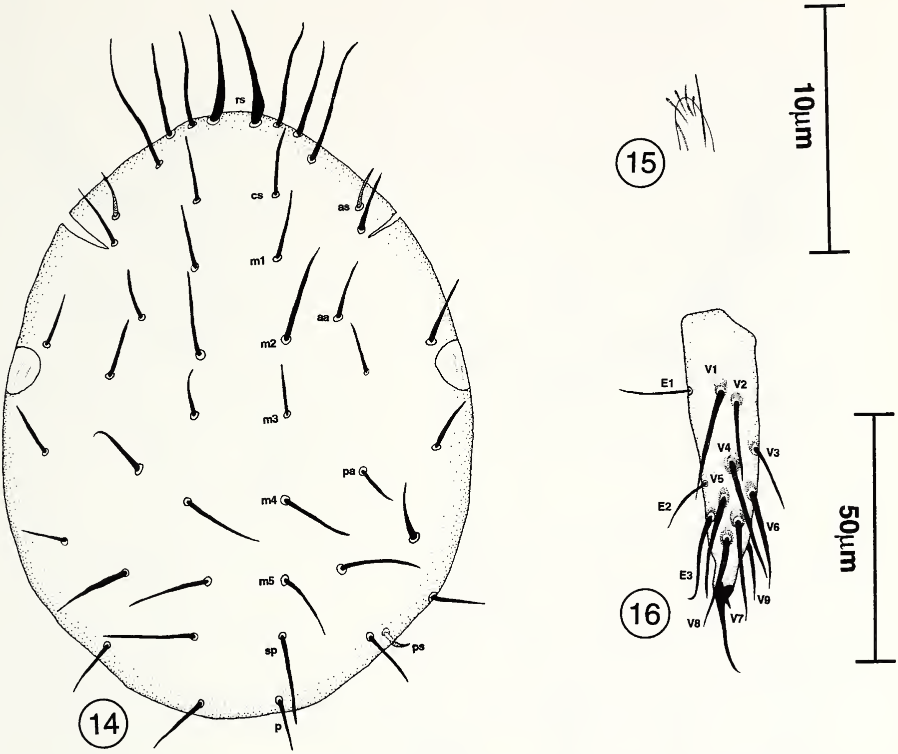




Figs. 12–13. *Eosentomon megatibiense:* 12, Postero-lateral margin of tergum VII; 13, Female squama genitalis.

(1.13–1.39, N = 23) than seta *p2* for both adult and maturus juniors. Gland openings distinctly visible anterior to seta *p2*. Mesonotum (Fig. 17) seta *p1* and *p1′* subequal in length. Seta *p2* 3.7 times length of *p2′* (3.2–3.9, N = 3); MJ = 3.5 (3.2–3.9, N = 20). Seta *p3* 2.8 times length of *p3′* (2.7–3.1, N = 3); MJ = 2.6 (2.2–2.8, N = 20). Seta *p3′* as long as width of mesothoracic spiracle. Setal and spiracular gland pattern on posterior and lateral margin of metanotum (Fig. 19) same as mesonotum except for presence of seta *p5′*.

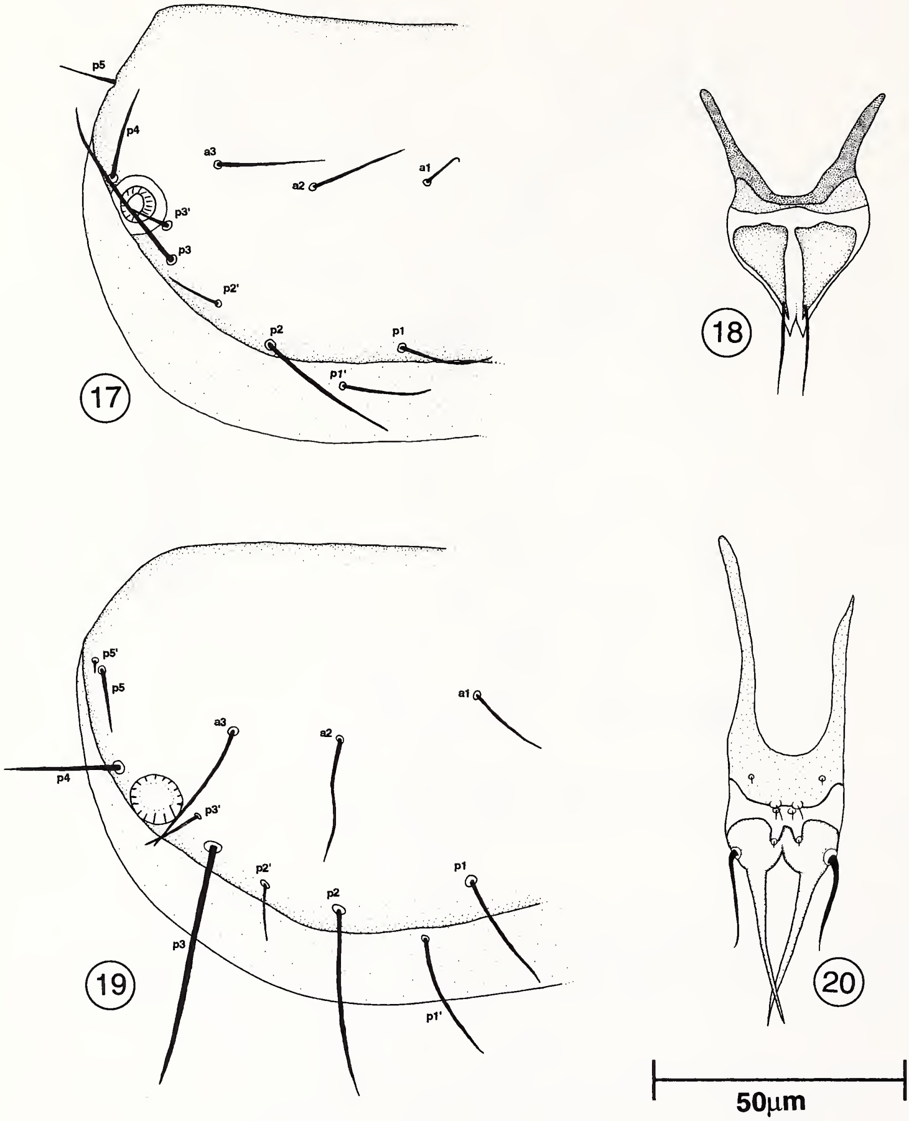
Tarsi. Foretarsi (Figs. 21, 22) without claw, 78.2 μm (77.6–78.8, N = 3); MJ = 65.7 μm (64.8–67.1, N = 20). Length of claw, 17.7 μm (16.9–18.1, N = 3); MJ = 15.0 μm (14.6–15.7). TR = 4.4 (MJ = 4.5); EU = 0.76 (MJ = 72). Empodia of mesotarsi short. EU II = 0.10 (0.09–0.12, N = 3); MJ = 0.10 (0.09–0.12, N



Figs. 14–16. *Eosentomon maryae.* 14, Head, adult, dorsal view; 15, Galea; 16, Metatarsus. (50 µm scale refers to Figs. 15 and 10 µm scale refers to Figs. 14 and 16.)

= 20). Empodia of metatarsi (Fig. 16) short. EU III = 0.12 (0.10–0.14, N = 3); MJ = 0.12 (0.09–0.14). Foretarsal hairs and sensilla in adults and maturus juniors similar except that sensilla *a′* does not reach *t2* in MJ (Fig 23). Foretarsal sensilla *a* and *c* small, linear; sensillum *b′1* absent; sensilla *a′, b, b′2,* linear; *f1* pointed spatulate; *t2,* linear, pointed; sensillum *a′* linear, long, reaching base of *t2*; sensilla *c′, f2,* and *t3* appear short and oblong but not distinct. Sensillum *d* oblong, linear; sensilla *e* and *g* thinly pointed spatulate clubs similar in size; *t1* oval with medium shank inserted closer to *α3′* than to *α3′*. BS = 1.26 (1.14–1.30, N = 3); MJ = 1.10 (1.08–1.12, N = 20).

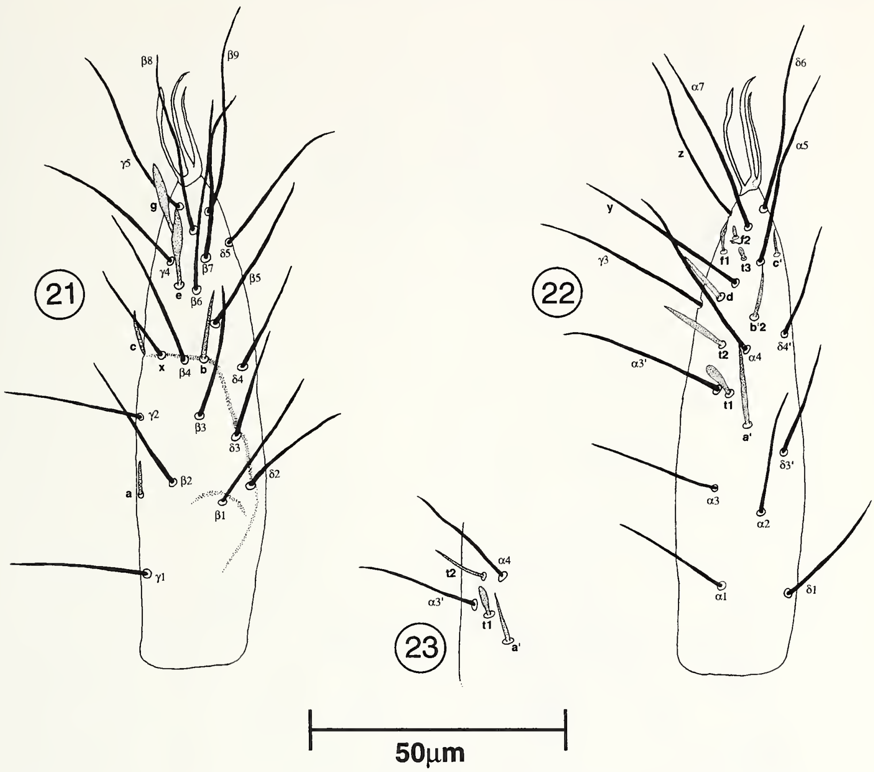
Abdomen. Abdominal chaetotaxy with plurals included in terga presented in Table 2. Posterior row of tergum I (Fig. 24) with three primary, one accessory, and two microchaetae. Tergites II–VI (Fig. 25) with accessory posterior setae subequal in length to associated primaries. First pair of accessory setae on tergum VII (Fig. 26) approximately one-fourth length of corresponding primaries, possessing a distinct brush tip. Tergum VIII (Fig. 27) with *p2′* slightly capitulate. Sternum VIII possessing two anterior and seven posterior setae. Sterna IX and X (Fig. 28) with six and four setae respectively. Central lobe of precosta deeply sinuate.



Figs. 17–20. *Eosentomon maryae.* 17, Postero-lateral margin of the mesonotum; 18, Female squama genitalis; 19, Postero-lateral margin of the metanotum; 20, Male squama genitalis.

Genitalia. Female squama (Fig. 18) with basal apodemes curving outward; processus sternales well sclerotized. Male genitalia (Fig. 20) not unusually distinctive.

Holotype. Female. Slide AK 56-31: Hot Springs National Park, Arkansas, August 26, 1977. T. Copeland. Type Deposition: American Museum of Natural History, New York, USA.



Figs. 21–23. *Eosentomon maryae*. 21, Fortarsus, ventral view; 22, Fortarsus, dorsal view; 23, Fortarsus, maturus junior, sensilla *t1* region.

Paratypes. 2 males, 20 matures junior. Village Creek Park, Arkansas, August 23, 1977. T. Copeland. Type Deposition: University of Arkansas Arthropod Collection, Fayetteville, Arkansas, USA.

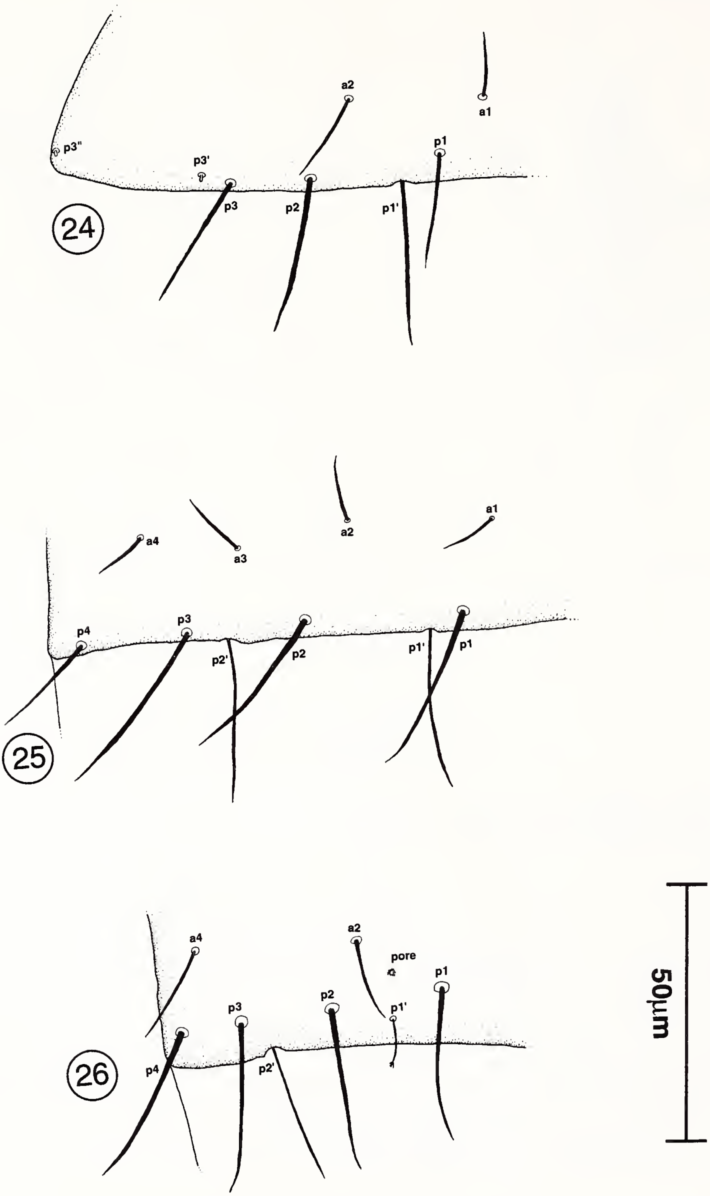
Etymology. This species is named after the primary author's mother.

Discussion. *Eosentomon maryae* is distinctive among the other members of *Eosentomon* exhibiting 6/4 setal arrangement on the sternites IX/X. The following key will be useful for separating the species of this group.

Table 2. Abdominal chaetotaxy of *Eosentomon maryae* n. sp.

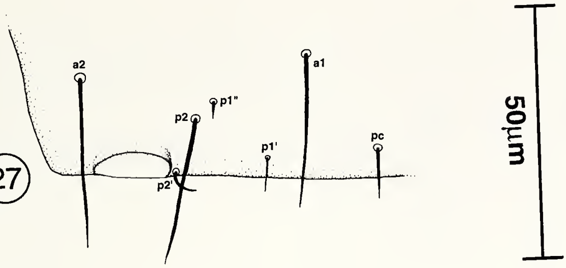
Abd	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Tergum	$\frac{4}{12^{a}}$	$\frac{10}{16}$	$\frac{10}{16}$	$\frac{8}{16}$	$\frac{8}{16}$	$\frac{8}{16}$	$\frac{6}{16}$	$\frac{6}{9}$	8	8	8	9
Sternum	$\frac{4}{4}$	$\frac{6}{4}$	$\frac{6}{4}$	$\frac{6}{10}$	$\frac{6}{10}$	$\frac{6}{10}$	$\frac{6}{10}$	$\frac{2}{7}$	6	4	8	12

[a] Three primary, one accessory, and two microchaetae on each side.

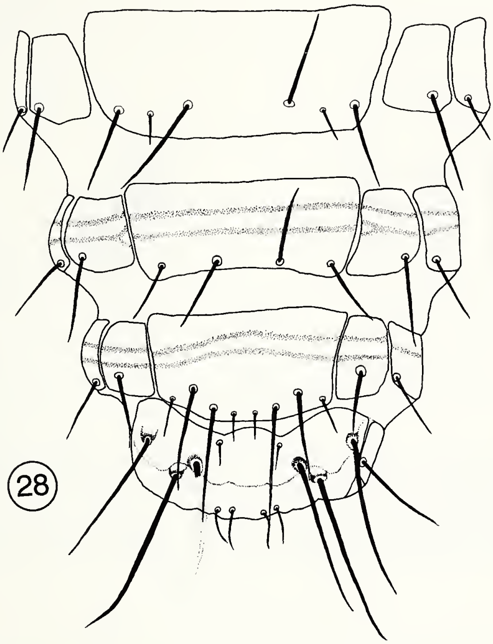


Figs. 24–26. *Eosentomon maryae.* 24, Postero-lateral margin of tergum I; 25, Postero-lateral margin of tergum II; 26, Postero-lateral margin of tergum VII.

(27)



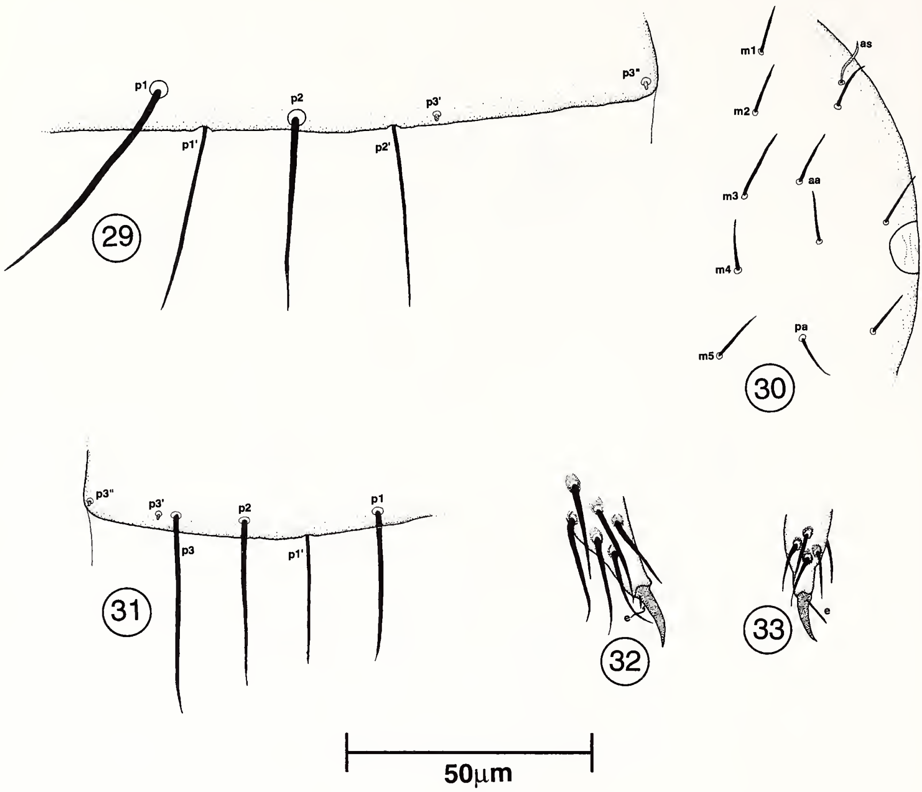
(28)



Figs. 27–28. *Eosentomon maryae*. 27, Postero-lateral margin of tergum VIII; 28, Sterna IX–XII.

KEY TO SPECIES OF *EOSENTOMON* WITH 6/4 SETAL PATTERN ON STERNA IX/X

1. a. First abdominal terga with 2:2:2 configuration of primary, accessory and microchaeta (Fig. 29) . . . . *E. megatibiense* Tipping n. sp.
   b. First abdominal terga with 3:1:2 configuration of primary, accessory and microchaeta (Fig. 31) 2
2. a. Empodia of metathoracic tarsi long, greater than fifty percent the length of claw (Fig. 33); cephalic seta *aa* absent . . . . *E. quapawense* Tipping
   b. Empodia of metathoracic tarsi short, less than thirty percent the length of claw (Fig. 32); cephalic seta *aa* present (Fig. 30) . . . . *E. maryae* Tipping n. sp.



Figs. 29–33. *Eosentomon* sp. 29, Postero-lateral margin of tergum I showing 2:2:2 setal pattern; *Eosentomon maryae*. 30, Lateral margin of head; *Eosentomon* sp. 31, Postero-lateral margin of tergum I showing 3:1:2 setal pattern; *Eosentomon maryae*. 32, Metatarsal claw with empodium; e, empodium. *Eosentonom quapawense*. 33, Metatarsal claw with empodium; e, empodium.

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THE BEE GENUS *RHECTOMIA* (HYMENOPTERA: HALICTIDAE): DISCOVERY OF THE MALE AND TWO NEW SPECIES

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Abstract.—A redescription of the augochlorine bee genus *Rhectomia* is presented and the male described for the first time. The genus *Corynurella* is found to be a junior synonym of *Rhectomia* and its sole species, *Corynurella mourei* Eickwort, is transferred to *Rhectomia.* Two new species are recognized: *Rhectomia harrisoni* and *R. liebherri.* A key is provided for the identification of the currently recognized species. Relationships within the genus are briefly discussed.

Key words: Augochlorini, *Corynurella,* Halictidae, new species, *Rhectomia,* synonymy.

The rare sweat bee genus *Rhectomia* is known from Argentina, Brazil, Paraguay, and Peru. The genus is a member of the New World tribe Augochlorini, most readily characterized by the apical cleft of tergum five in the female and the absence of a pygidial plate in the male. While the biology of the augochlorine genera is fairly well studied, nothing is known of *Rhectomia* species. The genus was erected by Moure (1947) for the new species *Rhectomia pumilla* and was described on the basis of the female only. Later, Eickwort (1969), in a generic revision of the Augochlorini, presented the description of a new genus and species, *Corynurella mourei,* sister to *Rhectomia.* Eickwort's new genus was based on both sexes; however, he recognized that with the discovery of the male for *Rhectomia* ". . . *Corynurella* should perhaps be considered a subgenus of *Rhectomia*" (Eickwort, 1969:400).

The present study gives descriptions of the recently recognized male for *Rhectomia* and two new species. The characters used by Eickwort (1969) to separate *Corynurella* from *Rhectomia*—size of the stigma and marginal cell—are found to intergrade, and *Corynurella* is best regarded as a synonym of *Rhectomia.*

The following abbreviations are used for institutions: AMNH, American Museum of Natural History, New York; CNC, Canadian National Collection, Ottawa, Canada; CUIC, Cornell University Insect Collection; KSEM, Snow Entomological Museum, University of Kansas; and PACK, L. Packer private collection.

Genus *Rhectomia* Moure

Rhectomia Moure, 1947, Publicações Avulsas Museu Paranaense no. 3:9. Type species: *Rhectomia pumilla* Moure, 1947, monobasic and original designation. Eickwort, 1969:400.

Corynurella Eickwort, 1969, University of Kansas Science Bulletin 48:398. Type species: *Corynurella mourei* Eickwort, 1969, monobasic and original designation. **New synonymy.**

Female: Rather small, *Dialictus*-like bees. *Head*: Epistomal sulcus forming slightly obtuse to right angle (measured between lateral clypeo-genal sulcus and dorsal clypeo-genal sulcus with angle opening towards compound eye: *sensu* Eickwort, 1969). Clypeus and supraclypeal area slightly protuberant in lateral aspect, both gently rounded. Preoccipital ridge rounded. Hypostomal ridge carinate and projecting beyond posterior margin of head, anterior angle broadly rounded; hypostomal bridge suture short; hypostomal length normal (longer than wide). Inner orbit of compound eye weakly emarginate; eyes moderately convergent below, more so than above; eye hairs short. Ocelli not enlarged. Vertex swollen behind ocelli. Scape long and slender; flagellomere 1 longer than wide; flagellomeres 2 and 3 equal in length, each shorter than remaining flagellomeres. Labral distal process narrowly triangular apically, with short broad base; basal elevation bilobed or orbicular and protuberant in profile. Mandible normal, subapical tooth weak. Base of galea distal to base of stipes, galeal comb present and well developed. Maxillary palpus normal, all segments of roughly equal length. Prementum not narrowed or elongated. Salivary plate with V-shaped brace. Glossa short. *Mesosoma*: Pronotal lateral angle strongly produced, carinate anteriorly; dorsal ridge carinate; lateral ridge carinate or sharply angled. Mesoscutum broadly rounded; mesoscutal lip produced over pronotum, low and rounded. Tegula semi-oval, smooth, and translucent. Propodeal triangle long, weakly impressed; dorsal ridge of propodeum rounded; lateral ridge rounded; propodeal pit narrow. Marginal cell acute at apex. Anterior basitarsal brush absent. Inner hind tibial spur pectinate, teeth rounded. Scopa formed on hind femur and distal half of trochanter by long, plumose hairs. Basitibial plate narrowly rounded, moderately sized, and well defined on all edges. *Metasoma*: Pseudopygidial area of tergum V semi-translucent and narrowly divided.

Male: As in the female except for the characteristics discussed below. *Head*: Clypeus and supraclypeal area slightly more protuberant. Scape shorter and wider than in female; flagellomere 1 and 2 of roughly equal length, each shorter than remaining flagellomeres; antenna moderately long, reaching back to scutellum. Labral basal area shorter than that of female; basal area low in profile, without elevation; distal process absent. *Mesosoma*: Inner hind tibial spur serrate. *Metasoma*: Elongated, but not petiolate. Pygidian plate of tergum VII absent. Gradulus of tergum VII absent. Anal lip of proctiger fringed with microtrichae, without anal filaments. Apical margins of sterna III–IV unmodified. Apical margins of sterna V and VI notched. Spiculum of sternum VIII narrow. Ventral bridge of gonobase broad, dorsal lobes strong. Basal process of gonostylus small, with setae. Penis valve without ventral prong or keel. Inner margin of volsella with depression.

Remarks: Most *Rhectomia* species can be quickly distinguished from other augochlorines by the peculiar pronotal dorsal ridge structures (Figs. 4–6), but this is not universal for the genus. The combination of the broadly rounded mesoscutum, strongly produced pronotal lateral angle, carinate dorsal ridge of the pronotum, pectinate inner hind tibial spur, swollen vertex, and weak eye emargination separates *Rhectomia* from other augochlorine genera. *Rhectomia* is apparently sister to *Rhinocorynura* as both genera share the fringe of microtrichae on the proctiger. *Rhectomia* can be separated from *Rhinocorynura* by the carinate dorsal ridge of the pronotum (the ridge is strongly lamellate in *Rhinocorynura*), the mesoscutal lip being low and rounded (this structure is high and sharply angled or carinate in *Rhinocorynura*), and

the lack of a keel on the ventral face of the penis valve. Both genera occupy a basal position in augochlorine phylogeny, near *Halictillus* and *Corynura,* as evidenced by the presence of a galeal comb, a feature lost in higher augochlorines. In a few males flagellomere 1 is slightly shorter than 2, each still shorter than the remaining flagellomeres.

Identification: The following changes for both females and males should be made to Eickwort's key to the genera and subgenera of Augochlorini (1969) in order to identify correctly *Rhectomia* as it is understood here; couplet 21 for each should read:

21. Pronotal dorsolateral angle produced, strongly carinate anteriorly and laterally; dorsal ridge carinate, usually with medial interruption placing the ridge on a distinctly separate plane from the pronotal lobe; mesoscutum broadly rounded and produced over pronotum, low and sharply angled; preoccipital ridge rounded. . . . . *Rhectomia*
    Pronotal dorsolateral angle not produced and not strongly carinate anteriorly; if lateral angle produced, dorsal ridge carinate; dorsal ridge never interrupted medially; lateral ridge, mesoscutum, and preoccipital ridge variable. 23

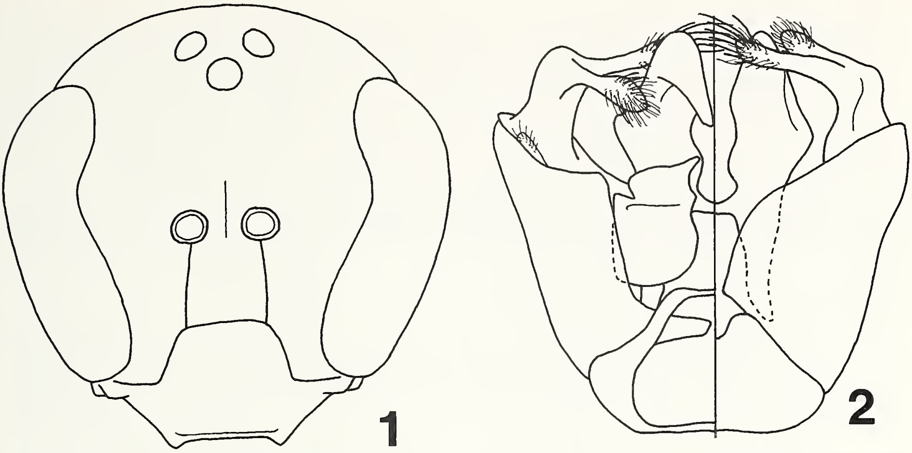
Couplet 22 should be deleted altogether.

A revised key to the genera and subgenera of Augochlorini is currently being prepared by the author.

Rhectomia harrisoni, new species
Figs. 1–2, 4

Female: Total body length 6.22 mm; forewing length 4.4 mm. Head about as wide as long. Epistomal sulcus roughly orthogonal (see generic description). Labral basal elevation orbiculate with slight median impression, not distinctly bilobed as in *R. pumilla* or *R. liebherri.* Frontal line weak but present between and slightly above antennal sockets. Gena as wide as compound eye in profile (genal width 0.44 mm). Distal half of clypeus projecting beyond lower tangent of compound eyes. Scape 0.7 mm in length. Vertex length 0.3 mm (measured from between lateral ocelli to preoccipital ridge). Pronotal lateral carina extending ventrally to junction between pronotum and propleuron. Pronotal dorsal ridge as in Fig. 4, weakly concave immediately behind lateral angle, with short, broad extension of dorsal ridge behind concavity; dorsal ridge with strong medial interruption setting the pronotal lobe on distinctly separate plane from dorsal ridge. Propodeal triangle roughly equal to scutellum in length, each longer than metanotum. Intertegular distance 1.16 mm. Second submarginal cell not narrowed anteriorly. Third submarginal cell wider than second, first approximately equal to width of third and second combined. 1r-m distad of 1m-cu, offset by about four times the width of a vein. 2r-m distad of 2m-cu, 2m-cu joining third submarginal cell two thirds of way through cell. Protrochanter approximately 3 times as long as wide; mesotrochanter approximately 2 times as long as wide; metatrochanter as long as wide. Inner hind tibial spur with three teeth (not including apex as a tooth), teeth decreasing in length distally.

Distal third of clypeus testaceous, remainder of clypeus and head dark metallic green with coppery reflections. Labrum brown. Mandible dark brown basally, testaceous medially, with reddish-brown tip. Scape yellow-brown, remainder of antenna dark brown. Face generally impunctate and shining; scattered weak punctures on upper half of face; clypeus with a few weak punctures basally. Pronotal lateral sur-



Figs. 1–2. *Rhectomia harrisoni* n. sp. 1. Frontal aspect of female head. 2. Male genitalia. Left half = ventral aspect; right half = dorsal aspect.

face brown, smooth and shining, finely imbricate just below pronotal lobe; propleuron brown; pronotal dorsal surface darker brown with strong metallic green highlights. Mesosoma, exluding pronotum, brown to red-brown with strong metallic green highlights. Mesoscutum, scutellum, metanotum, and pleura with very few scattered weak punctures, smooth and shining. Median line, parapsidal lines, and median scutellar impression weak. Propodeal triangle smooth and shining. Lateral surfaces of propodeum impunctate and imbricate. Tegula light brown, darker along inner margin. Forecoxa and forefemur brown, remainder of leg light brown; legs of mesothorax and metathorax brown. Basitibial plate light brown with reddish-brown rim. Metasoma brown. Terga impunctate.

Face with short, plumose, appressed golden hairs and scattered simple hairs. Vertex with scattered short simple hairs; hairs longer on gena; postgena with few hairs; row of short simple hairs along hypostomal ridge. Short simple hairs scattered over mesoscutum, a few longer hairs interspersed among shorter ones. Scutellum with short simple hairs and scattered longer brancheal hairs. Metanotum with shorter hairs denser than on scutellum, but not obscuring surface; long branched hairs present as on scutellum. Pleura with scattered short branched hairs and fewer long branched hairs, longer hairs becoming more dense ventrally. Lateral surfaces of propodeum with scattered long simple and branched hairs, also with scattered short simple hairs; posterior surface with shorter hairs more sparse and longer hairs with more branches. Inner face of metatibia without hairs, remainder densely covered with stiff branched hairs, branches short; similar hairs on outer face of metabasitarsus, but not as dense. Terga with few simple hairs; hairs more dense and becoming branched laterally on terga II–VI, branches short. Hairs more numerous dorsally on terga IV–VI. Hairs long and with short branches on sterna; hairs on sternum I with long branches.

Male: Total body length 7.32 mm; total forewing length 4.76 mm. Structure as in the female except as follows: Head longer than wide. Clypeus much more protuberent; distal half projecting below lower tangent of compound eyes. Gena as wide as compound eye in profile. Vertex slightly more swollen than in female (length 0.36 mm). Scape short (length 0.54 mm). Intertegular distance 1.22 mm. Inner hind tibial spur serrate. Sternum I longer than wide. Notch on apical margin of sternum V wide with short medial projection; dense erect setae on projection; patch of dense erect setae on inner borders of notch. Genital capsule as in Figure 2. Volsella with short median, apical hook on digitus. Ventral gonostylar process broader distally than basally, coming to a pointed apex.

Integument coloration and sculpturing as in the female except as follows: Distal half of clypeus testaceous. Mandible yellow-brown with red tip. Outer surfaces of meso- and metatibiae brown, remainder as in female. Metasoma coloration variable. Allotype male with tergum I brown with apical margin yellow-brown. Terga II and III each with basal band of yellow-brown, apical margins semi-translucent, remainder brown. Terga IV–VII brown with semi-translucent apical margins.

Pubescence as in the female except for usual sex differences. Metatibia and metabasitarsus with scattered long, simple hairs.

Type Material: Holotype female, Brazil, Mato Grosso, Itaum, Dourados, March 1974, M. Alvarenga (KSEM). Allotype male, same data as holotype (KSEM). One paratype female, Paraguay, Villarrica, 3 December 1951, F.H. Schade (KSEM). One paratype male, Paraguay, Villarrica, February 1938, F. Schade (KSEM). One paratype female [macrocephalic], Paraguay, Villarrica, September 1937, F. Schade (KSEM). One paratype male, Paraguay, Itapua, Pirapo NE of Encarnación, 29 December 1971, L. Peña (CUIC). One paratype male, same data as holotype (CUIC). Two paratype males, Paraguay, Villarrica, January 1938, F. Schade (CUIC). One paratype male, Paraguay, Caaguazu, Coronel Oviedo, 21 December 1971, L. Peña (AMNH).

Additional Material: One male, Argentina, Misiones Prov., Iguazu NP, Cent. Ecol., 24 December 1990 to 6 January 1991, S. & J. Peck, 90/131, Forest edge FIT [flight intercept trap], 180 m (CNC). One male, Paraguay, Caaguazu, Coronel Oviedo, 21 December 1971, L. Peña (PACK).

Remarks: Males of this species vary in the coloration of the metasoma, from having the terga completely brown to the basal two terga being completely yellow-brown. Additionally, the Argentine male has more of a blue-green color to the head and mesosoma than the other specimens; however, all of the structual characteristics and the genitalia are identical. One paratype female in CUIC is macrocephalic compared to the remaining specimens (measurements for macrocephalic female: genal width 0.72 mm; vertex length 0.44 mm). Head polymorphism is one possible indication of social behavior and in some primitively eusocial sweat bees it is associated with caste development (e.g., Sakagami and Fukushima, 1961). Such head polymorphism is also known from other augochlorine genera (Sakagami and Moure, 1965). Lastly, there are three mites on the left hindwing of the holotype. Associations between mites and sweat bees are common, although poorly understood (Eickwort, 1979, 1994).

Etymology: This species is named in honor of Dr. Richard G. Harrison, of Cornell University, for his aid and guidance of my work on the Augochlorini.

Figs. 3–6. Pronotal lateral angles and dorsal ridges of *Rhectomia* species, dorsal aspect, left side. 3. *Rhectomia liebherri* n. sp. 4. *Rhectomia harrisoni* n. sp. 5. *Rhectomia mourei* (Eickwort). 6. *Rhectomia pumilla* Moure.

Rhectomia liebherri, new species
Fig. 3

As in *R. harrisoni* except as follows:

Female: Total body length 6.32 mm; forewing length 4.8 mm. Epistomal sulcus slightly obtuse (see generic description). Labral basal elevation bilobed. Frontal line weakly carinate between antennae, replaced by weak impression above towards median ocellus. Scape length 0.7 mm. Vertex not quite as long, length 0.22 mm. Pronotal lateral ridge sharply angled, ridge not reaching juncture between pronotum and propleuron; dorsal ridge straight (Fig. 3), without concavity or extensions as present in the other species; medial interruption absent. Propodeal triangle slightly longer than scutellum. Intertegular distance 1.18 mm. Inner hind tibial spur with four teeth.

Overall body coloration darker than in *R. harrisoni.* Labrum dark brown. Clypeus and supraclypeal area dark brown with green highlights; mandible dark brown. Scape dark brown. Face punctate; punctures separated by puncture width; punctures weaker and sparser on clypeus and supraclypeal area; punctures disappearing on vertex. Mesosoma dark brown with strong metallic green highlights; highlights weaker on propodeum. Propodeal triangle finely imbricate and not shining. Legs brown. Basitibial plate not lighter in color than remainder of leg. Metasoma entirely dark brown.

Face without appressed plumose hairs, with scattered short, simple hairs. Remainder of pubescence as in *R. harrisoni.*

Male: Unknown.

Type Material: Holotype female, Brazil, São Paulo, Serra da Bocaina, S. Jose Barreiro, 1650 m, November 1968, M. Alvarenga (KSEM). Two paratype females, same data as holotype (KSEM). One paratype female, same locality data as holotype but date October/November 1969, Alvarenga and Seabra (CUIC). One paratype female, Brazil, São Paulo, Serra da Bocaina, S. Jose Barreiro, 1960 m, November 1970, M. Alvarenga (CUIC).

Remarks: This species is notable for the lack of a medial interruption in the pronotal dorsal ridge, the sharply angled lateral ridge not extending all the way to the propleuron, and its dark color.

Etymology: This species is named in honor of my advisor Dr. James K. Liebherr, of Cornell University, for his assistance and advice during my studies of neotropical sweat bees.

Rhectomia mourei (Eickwort), **New Combination**
Fig. 5

Corynurella mourei Eickwort, 1969, University of Kansas Science Bulletin 48:514.

Remarks: Eickwort (1969) provided a detailed description of this species in his seminal work on the tribe Augochlorini. A complete redescription of the species is not needed. *R. mourei* is known from Southern Brasil and Peru. The holotype female, allotype male, and several paratypes are in KSEM (examined). Three additional females and one male (not paratypes) are in CUIC, with the following locality information: Females, Rio de Janeiro, Brazil, October 1938, Yellow Fever Service, MES Brazil, R.C. Shannon; 2 from Brazil, Guanabara, Represa Rio Grande, May 1971, M. Alvarenga & F. M. Oliveira. Male, Brazil, Guanabara, Repressa Rio Grande, July–August 1972, M. Alvarenga.

Diagnosis: Labral basal elevation orbicular. Distal third of female clypeus yellow-brown. Face with short, plumose, appressed hairs. Pronotal dorsal ridge as in Figure 5, weakly concave immediately behind lateral angle followed by a short, broad extension (structure similar to that in *R. harrisoni*), with medial interruption as described for *R. harrisoni* except not as strong. Mesosoma reddish-brown with green hints. Propodeal triangle with fine concentric striae and shining. Female metasomal terga I–III completely testaceous. Male terminalia figured by Eickwort (1969:his figures 335–336, p. 483).

Rhectomia pumilla Moure
Fig. 6

Rhectomia pumilla Moure, 1947, Publicações Avulsas Meseu Paranaense no. 3:9.

Remarks: Moure (1947) described this species in detail and a redescription is not needed at this time. The holotype female is in the Moure Collection, Universidade Federal do Paraná, Curitiba, Brazil, and was not available for study. The locality data given for the type series (holotype and one paratype) by Moure is as follows: Brazil, Curitiba, Pr. 900 m, 30 October 1939 and November 1939, J. S. Moure (on flowers of a small Euphorbiaceae). The specimen at my disposal has the following locality information: Female, Nova Teutonia, Santa Catarina, Brazil, December 1952, F. Plaumann (KSEM).

Diagnosis: Labral basal elevation distinctly bilobed. Labrum and mandibles dark brown. Clypeus entirely dark brown with some green highlights basally. Face without appressed, plumose hairs. Pronotal structure as in Figure 6, strongly concave behind lateral angle, followed by a moderately-sized, thin lateral extension, with medial interruption as described for *R. harrisoni.* Eickwort (1969) has also figured the distinctive pronotal dorsal ridge for *R. pumilla* (his figure 185). Propodeal triangle imbricate and not shining. The male for this species remains undiscovered.

Two additional species are known from only one male each. The locality information for these two is as follows: Peru, Avispas, 156 km from Puerto Maldonado, Madre de Dios Prov., 1–15 October 1962, L. E. Peña (CUIC); and Brazil, Minas Geraes [sic], Santa Barbara, 1,450 m, Serra do Caraca, March 1971, F. M. Oliveira (KSEM). The male from Santa Barbara is similar to *R. liebherri,* but has a distinctly carinate pronotal lateral ridge and a more punctate face and mesoscutum.

Lastly, one undescribed species is known to me on the basis of one female. This specimen is similar in character to *R. harrisoni* except the head is longer than wide and the propodeal triangle has fine striations radiating from the basal margin. The locality data for this female are as follows: Brazil, Nova Teutonia, Santa Catarina, 18 February 1954, F. Plauman (KSEM).

KEY TO THE DESCRIBED SPECIES OF *RHECTOMIA*

This key is for males and females. Characters used in the key are hypothesized to be the same for the males of *R. liebherri* and *R. pumilla* as they are in the females of these species.

1. Pronotal lateral ridge forming a distinct carina which extends ventrally to the juncture between the pronotum and propleuron; face with short, plumose, appressed hairs. 2
   Pronotal lateral ridge carinate or sharply angled, not extending down to propleuron; face without such appressed hairs. 3
2. Pronotal lateral surface behind lateral ridge with strong dorso-ventral striations, lateral ridge as in Figure 5; labral basal elevation orbicular, with very slight medial impression; metasomal terga I–III testaceous (females only: males are variable for this character); propodeal triangle with very fine striae. . . . . *mourei*
   Pronotal lateral surface behind lateral ridge smooth, lateral ridge as in Figure 4; labral basal elevation distinctly bilobed; metasomal terga dark brown to black (females only: males are variable for this character); propodeal triangle smooth. . . . . *.harrisoni*
3. Pronotal dorsal ridge strongly concave just behind lateral angle and forming short extension or flange just behind concavity (Fig. 6). . . . . *.pumilla*
   Pronotal lateral ridge straight, not interrupted by concavity or flange (Fig. 3) . . . *liebherri*

RELATIONSHIPS

It is too early at this time to present an analysis of the internal phylogeny for *Rhectomia*. However, a few observations on relationships can be made. Based on the pronotal structure of other basal augochlorine genera (e.g., *Rhinocorynura, Halictillus,* and *Corynura*), R. liebherri would appear to be the basalmost species currently recognized. The three undescribed species along with *R. harrisoni, R. mourei,* and *R. pumilla* all share an extended pronotal lateral carina which reaches the ventral border near the propleuron. This character is derived within the genus and separates these species from *R. liebherri.* The two undescribed males, while having the extended pronotal lateral carina, have unmodified pronotal dorsal ridges and are therefore basal with respect to a clade containing *R. harrisoni, R. mourei, R. pumilla,* and the undescribed Brazilian female. The complex structure of the pronotal dorsal ridge (Figs. 3–6) seemingly forms a transition series from the plesiomorphic condition seen in *R. liebherri* (Fig. 3) and the undescribed males, to the more complex structures seen in the remaining species (Figs. 4–6). It is difficult to determine whether the pronotal dorsal ridge of *R. mourei* is intermediate between *R. liebherri* and a clade containing *R. harrisoni, R. pumilla,* and the undescribed female, or if this species is more closely aligned with *R. harrisoni* and the undescribed female species. In the first scenario, the three species grouped all share a strong lateral projection even though the overall structure of the curve is similar in *R. mourei* and *R. harrisoni* + the undescribed female. However, in the second case, *R. mourei, R. harrisoni,* and the undescribed female all share an orbicular labral basal elevation, lacking the

bilobed structure seen in *R. liebherri* and *R. pumilla.* In the opinion of the author, the second situation is probably more strongly supported.

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THE FIRST SPECIES OF *ARADACRATES* FROM MALAYA AND A NEW SPECIES OF *PRAETORBLISSUS* FROM COSTA RICA (HETEROPTERA: LYGAEIDAE; BLISSINAE)

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Abstract.—The genus *Aradacrates* Slater has been previously known only from a single species from Madagascar. *Aradacrates malayensis* is described and illustrated as a new species from Malaya. Included is a discussion of the possible function of shining raised abdominal plates and notes on an early instar nymph. The second species of *Praetorblissus* Slater, *Praetorblissus brailovskyi* is described from bamboos in Costa Rica.

The Blissinae have been studied intensively in recent decades by the author and his colleagues, with 57% of the 435 species being described since 1960 (Slater and O'Donnell, 1995). Nevertheless some of the most unusual and striking species live in cryptic habitats and are rarely collected. Thus we can expect important additions to the fauna particularly of those species living in bamboos, or having very restricted ranges. In this paper two such species are described. The first, a member of the genus *Aradacrates* is reported from the Orient for the first time, the only previously known species being from Madagascar. The second species in the plesiomorphic genus *Praetorblissus* is one of the most micropterous blissines known, the mesothoracic wings being reduced to minute scale-like flaps.

ARADACRATES SLATER AND WILCOX

Aradacrates Slater and Wilcox 1969:439–440.

Type species: *Aradacrates cochlear* Slater and Wilcox. Monobasic.

The genus *Aradacrates* was established by Slater and Wilcox (1969) for a single species from Madagascar. These authors noted the similarity of the produced bucculae to the condition found in the genus *Iphicrates* Distant. They considered the relationship to be convergent and the true phylogenetic affinities to be with another Madagascar endemic, *Aradademus* Slater.

Aradacrates is characterized by the elongate, slender, linear body, the strongly incrassate short and spined femora and tibiae. The fore femur bears a single large ventral bifid spline. The first segment of each tarsus is greatly enlarged, almost as long as the heavy tibiae and bears a mat of long hairs on the ventral surface. The dorsal and ventral surfaces lack any pruinosity. The metathoracic scent gland auricle curves anteriorly. Abdominal segments 2 or 3 to 5 are fused. The labium is short, not attaining the mesosternum.

It is important now to be able to examine a species of this striking genus from southeast Asia. It is another example of the relationships often shown by the fauna and flora of Madagascar and Indomalaya. This is probably indicative of old taxa

which formerly had a contiguous distribution in the Paleotropics, now disjunct by intervening areas of aridity.

Aradacrates malayensis, new species
(Figs. 1, 2)

Body very elongate, slender, parallel sided. Head, pronotum, scutellum, pleuron, sternum and antennae black. Abdomen dark red brown, almost black especially on sternum with connexivum bright red brown. Apex of tylus, bucculae and legs bright yellow. Clavus and corium dull grayish-white with contrasting yellow cubital vein and with medius and radius anterior to level of apex of clavus also yellow, but shading to almost black posteriorly. Membrane fumose with a broad pale yellow border and a narrow pale streak through middle of basal half. Body with exception of hemelytra shining; no pruinosity present. Hemelytra dull, except for shining veins and area along lateral corial margins. Clothed with decumbent sericeous silvery hairs. Head, pronotum and scutellum granulose rather than distinctly punctate.

Head short, broad, eyes produced, but not stalked, set a short distance away from anterior pronotal margins. Bucculae broad and cup-shaped, extending anteriorly well beyond apex of tylus, but oriented dorso-ventrally to almost enclose sides of tylus, rather than being dorso-ventrally flattened, not attaining distal end of first antennal segment. Length head 0.72, width 0.94, interocular space 0.60. Pronotum parallel sided on posterior one-third, slightly tapering anteriorly. Transverse impression obsolete. Posterior pronotal margin concave before base of scutellum. Length pronotum 1.52, width 1.68. Scutellum with a smooth, slightly elevated median line. Length scutellum 1.0, width 0.80. Radial vein of corium sharply ridged and bearing a line of coarse punctures. Membrane attaining middle of abdominal tergum eight. Length claval commissure 0.68. Midline distance apex clavus-apex corium 2.00. Midline distance apex corium-apex abdomen 2.96. Apex of abdomen broadly truncate. Metathoracic scent gland auricle elongate, almost attaining lateral margin of pleuron, bent forward distally at a right angle. Evaporative area covering entire anterior lobe of metapleuron. Prosternum with a broad mesal trough. Meso- and metasternum smooth and polished. All abdominal sterna smooth and polished mesally, these areas extending laterad as large lobes both anteriorly and posteriorly on sterna 5 through 7 and contrasting strongly with adjacent sericeous areas of abdomen. Abdominal segments 3–5 fused, but suture between 4 and 5 visible. All femora short and strongly incrasssate. Fore femur with a large distal bifid spine and a series of upstanding setae. Middle and hind femora each with a series of short, stout spines. Tibiae very short and stout with coarse setiferous splines along shaft. First tarsal segment very large and broad with a thick pad of hairs on ventral surface. Labium short, not reaching onto mesosternum. Length labial segments I 0.42, II 0.56, III 0.30, IV 0.30 (approx.). Antennae terete or slightly fusiform. Length antennal segments I 0.18, II 0.52, III 0.60, IV 0.69 (approx.). Total body length 9.24.

Holotype: ♂. MALAYSIA: Kedah, Genung Jerai (top), 23.VII.1992, 1200 m. (C. W. & L. B. O'Brien). In American Museum of Natural History.

Paratypes: 2♀♀ Same data as holotype. In Instituto de Biologia (UNAM) and J.A. Slater collections.

Readily separable from the type species *A. cochlear* by its much larger size: over

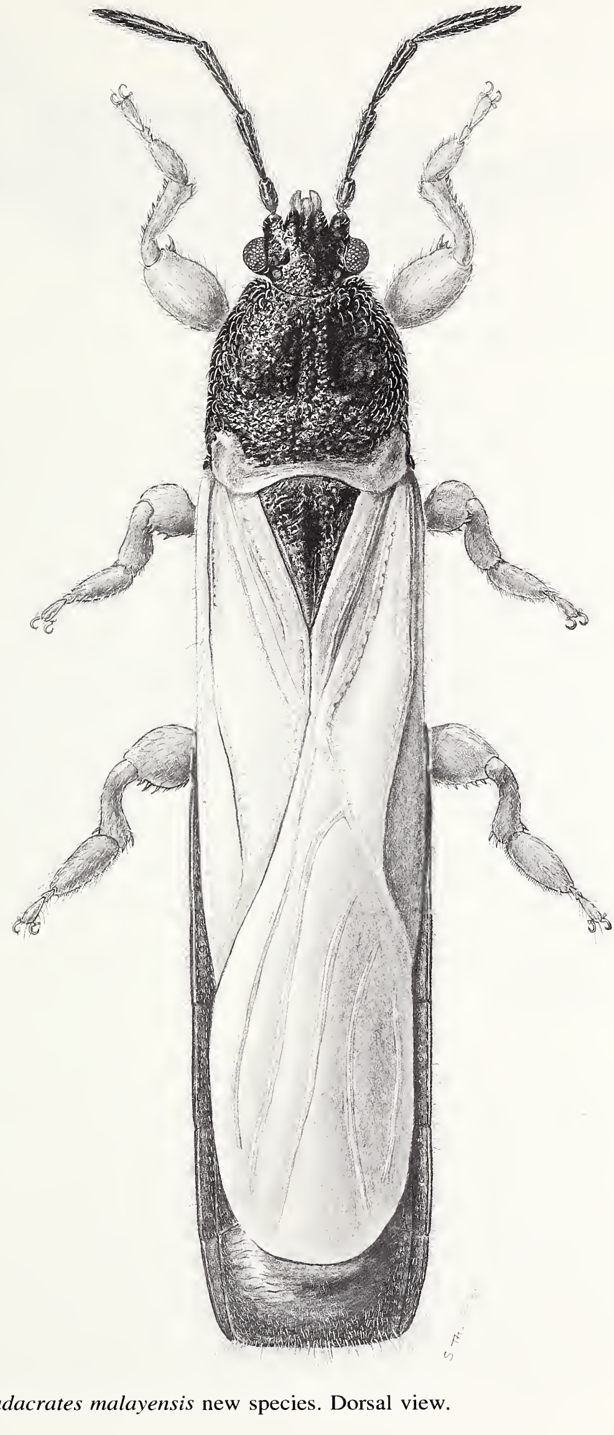

Fig. 1. *Aradacrates malayensis* new species. Dorsal view.

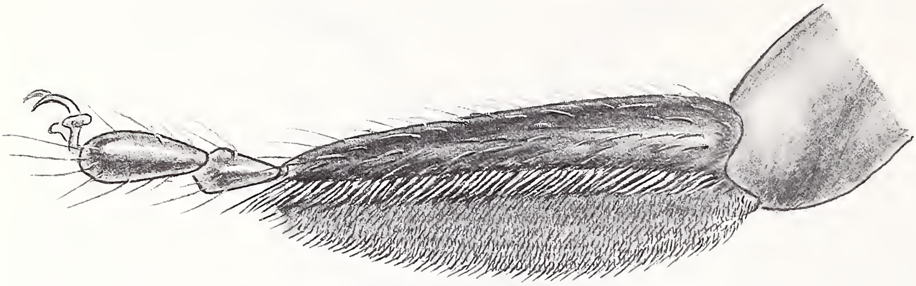

Fig. 2. *Aradacrates malayensis* new species. Fore tarsus.

9 mm (less than 5 mm. in the only known specimen of *A. cochlear*). *A. malayensis* can also be readily distinguished from the type species by having much less elongate bucculae which are not strongly splayed out, nor notched along the lateral margin. The scutellum is ¼ longer than the length of the head in *A. malayensis* (subequal in *cochlear*). The second labial segment is longer than segment one in *A. malayensis* but the reverse in *A. cochlear* (23:19). The second antennal segment is much more than twice as long as segment one in *A. malayensis* (18:52) whereas in *A. cochlear* the second segment is less than twice as long as segment one (15:27).

Although nothing is known of the biology, like several other elongate, slender, polished Blissinae this species shows several apparent structural modifications that probably are to aid it in sliding between the closely appressed sheaths of monocots (bamboos?). This is particularly evident when one examines the ventral surface of the abdomen. The general surface is granular and covered with short decumbent hairs. Contrasting strongly are polished areas on sterna four through seven. On sternum four the entire central area is polished with arm like extensions projecting antero-laterad and posteriorly along the posterior margin. On segment five a pair of large convex circular macula coalesce posteriorly and expand along the posterior margin. Segment six has similar lateral convex maculae but the central area is also polished. On the seventh segment only a broad elliptical central area is polished. In addition the radial vein and to an extent the vein on the clavus are both raised above the surface and polished.

PRAETORBLISSUS SLATER

Praetorblissus Slater 1966:3–8.

Type species: *Praetorblissus gigas* Slater. Monobasic.

This is a genus of very large and very rare blissines. It was originally described from South America where three species are now known to occur (Peru and Bolivia). It was first reported from Central America by Slater and Ashlock's (1976) description of *P. obrieni* from Costa Rica. In this paper Slater and Ashlock discussed in detail the importance of this genus for phylogenetic relationships in the Blissinae. The species are known from only a very few specimens and only a single macropter is known. They are large blissines with multispinose fore femora, but differ from the

other large Neotropical Blissinae in having closed fore coxal cavities. Slater and Ashlock (*in* Slater, 1979) placed them near the base of the cladogram of the Blissinae. It is thus important to place on record a second species of the genus from Central America and to establish a bamboo as the host plant of this species.

Praetorblissus brailovskyi, new species

Body flattened dorso-ventrally, polished and shining with pruinosity restricted to a narrow strip mesally on prosternum and ventrally along base of head. General coloration including antennae, black to very dark chocolate brown, posterior pronotal lobe partially sordid yellow. Abdominal tergum within connexivum and legs dark red brown. Glabrous above. Head rugulose. Anterior pronotal lobe smooth except for fine punctures on and around anterior collar and a large impressed puncture inside of each calli surface. Posterior pronotal lobe and wing pads coarsely punctate, abdominal tergum finely punctate. Scutellum conspicuously punctate only laterally.

Head non-declivent, eyes small, set well away from antero-lateral pronotal margins. Tylus extending to middle of first antennal segment. Length head 0.94, width 1.22, interocular space 0.84. Pronotum broad, lateral margins straight from humeral angles to anterior one-third then curving evenly convexly mesad; a well differentiated anterior collar present; anterior lobe with a conspicous median longitudinal sulcus. Posterior pronotal margin straight. Length pronotum 1.48, width 2.16. Scutellum very broad and short, a slight median elevation on distal half. Length scutellum 0.80, width 1.80. Wing pads reduced to small scales that leave most of metanotum exposed and are remote from first abdominal segment. Length wing pad 1.06. Length abdomen 3.60. Metathoracic scent gland auricle short and thick, curving anteriorly at a right angle, broadly blunt at distal end. Fore femur strongly incrassate, armed below with one very large black spine and a double series of small black spinules. Middle and hind femora also incrassate, armed below with a series of small inconspicuous spines. Labium extending posteriorly beyond fore coxae onto anterior portion of mesosternum. Length labial segments I 0.72, II 0.84, III 0.76, IV 0.56 (approx.). Length antennal segments I 0.36, II 0.88, III 0.76, IV 1.20. Total body length 8.05.

Holotype: ♂ COSTA RICA: Prov. Alajuela, Volcan Poas, 21.I.1995 (in leaf sheath of an unknown species of bamboo). (H. Brailovsky, B. Kohlman). In Instituto de Biologia UNAM, Mexico.

Paratype: 1 ♀ Same data as holotype. In J. A. Slater collection.

P. basilovskyi is most closely related to the other known Costa Rican species (*P. obrieni*) but differs in being a much larger, more robust species and is readily distinguishable by the dark reddish legs and the dark abdominal connexivum which is concolorous or darker than the abdominal tergum. In *P. obrieni* the legs and abdominal connexiva are pale yellow and contrast strongly with the nearly black body coloration.

In *P. brailovskyi* the exposed metanotum is dull and finely granulose and the reduced mesothoracic wing pads are straight or slightly concave along their inner margins. These wing pads extend posteriorly beyond the apex of the scutellum. In *P. obrieni* the wing pads are very small, rounded on the inner margin and do not extend posteriorly nearly to the apex of the scutellum.

Nymphs of *Praetorblissus* have not been previously known. A single nymph, probably conspecific with the adults, was taken with them. Unfortunately it is an early instar, probably the second. The only sclerotization on the abdominal venter is a series of median plates on sterna 5–8 (SM 5–SM 8) (see Slater, 1979 for code to nymphal sclerites). Only the apex of the abdomen is sclerotized dorsally (TM 8–TM 9). No sclerotized plates are differentiated around the dorsal abdominal scent gland openings. This nymph is pale sordid yellow, including the appendages, with the mesal area of the abdomen reddish brown.

This species is named for Dr. Harry Brailovsky (Instituto de Biologia UNAM), who collected the type specimens, and for his many important contributions to our knowledge of Neotropical Heteroptera.

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NEOCORYNURA ELECTRA, A NEW FOSSIL BEE SPECIES FROM DOMINICAN AMBER (HYMENOPTERA: HALICTIDAE)

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Abstract.—A new fossil bee species, *Neocorynura electra,* is described and figured. The species is known from one female in the Upper Oligocene or Lower Miocene amber deposits of the Dominican Republic. No species of *Neocorynura* are known to occur in the Greater Antilles today. This is only the fourth halictid species known from amber inclusions. A brief discussion of augochlorine biogeography in the Caribbean is presented.

Key words: Augochlorini, Dominican amber, fossil bee, Halictidae, *Neocorynura.*

One group of bees can be quite common in Dominican amber, i.e., the stingless bees (Apidae: Meliponini), which are abundant to the extent that specimens can be readily purchased in gem shops. Fossils of the bee family Halictidae, however, are uncommon. Engel (1996) recently reviewed the described fossil halictid species of the world and listed only nine taxa, four of which were from Dominican amber inclusions. As noted by Engel (1996), the rarity of halictids in amber is probably due to the fact that most species nest in the soil and do not collect tree resins, thus making it unlikely for them to come into contact with sap. Some species of the augochlorine genus *Neocorynura* are known to nest in wood (Schremmer, 1979), and although this is not universal for the genus (Michener, 1977; Michener and Lange, 1958; Michener et al., 1966; Sakagami and Moure, 1967), it would make this group more likely than other halictid taxa to be preserved in amber. The specimen described herein is representative of this genus and was listed as "*Neocorynura* sp." in Engel's summary of fossil Halictidae (1996: his table 1).

The *Neocorynura* species described below is from the amber mines of the Dominican Republic. These mines are estimated to be approximately 30 million years old (Lower Miocene to Upper Oligocene) based on stratigraphic evidence (Grimaldi, 1995). Lambert et al. (1985) determined a broad range of ages for Dominican amber (15–40 million years; Mid Miocene to Upper Eocene), but Grimaldi (1995) has critiqued their NMR estimates for amber ages. Aside from the stratigraphic data, the faunal representation of bees in the Dominican deposits also argues for a younger age than the potentially Eocene age suggested by Lambert et al. (1985). The Dominican amber bee fauna is more similar to today's fauna than the 40 million year old Baltic amber fauna, suggestive of a much younger age. All of the Dominican amber bees (see review in Michener and Poinar, 1996) are assignable to modern genera or to extinct genera close to present day forms (e.g., *Oligochlora*). Baltic amber bees such as *Electrapis, Glyptapis,* or *Chalcobombus,* however, are radically different from modern taxa and their assignment even to higher groups is questionable.

Neocorynura (Neocorynura) electra, new species
Figs. 1–4

Description: Based on a single female specimen. Total body length 7 mm; total forewing length 4.9 mm; head width 1.68 mm; head length 1.28 mm; scape length 0.84 mm; intertegular distance 1.36 mm. All measurements were made with an ocular micrometer on a WILD-M5a microscope and are approximate as the best angle for taking readings was often not possible due to the uneven surface of the amber.

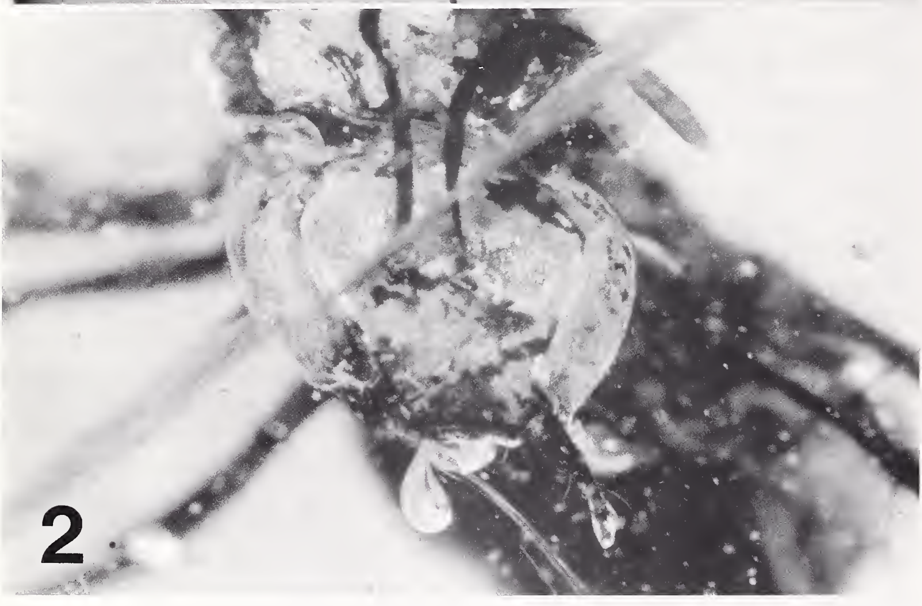
Head slightly wider than long (Fig. 2). Angle of epistomal sulcus obtuse, as measured between lateral clypeo-genal sulcus and dorsal clypeo-genal sulcus with angle opening towards the compound eye (*sensu* Eickwort, 1969). Clypeus and supraclypeal area not protuberant, gently rounded and low. Mandible monodentate, slender; subapical tooth very weak; distal half of clypeus extending beyond lower tangent of compound eyes. Labrum and labio-maxillary complex not visible. Frontal line short, carinate between antennae, disappearing just above the antennal sockets. Compound eyes strongly emarginate and convergent below. Ocelli not enlarged, closer to one another than to compound eyes. Antenna below line of eye emargination; scape long; pedicel slightly shorter than first flagellomere; flagellomere I constricted basally, longer than wide, seemingly slightly longer than II; II–VII not easily visible, seemingly about as wide as long from II–V, then VI–VIII becoming slightly longer than wide; IX slightly longer than wide; distal flagellomere twice as long as wide. Vertex short. Gena difficult to see due to curvature of the amber surface, however seemingly narrower than compound eye. Preoccipital ridge not easily visible, presumably carinate. Pronotal lateral angle orthogonal, slightly produced and sharp; ridge between lateral angles carinate; dorsal and lateral ridges carinate. Pronotal lobe moderately produced to form a blunt tubercle. Mesoscutum narrowed anteriorly and projecting over pronotum; mesoscutal lip high and rounded. Median and parapsidal lines moderately impressed. Tegula normally rounded; smooth with short, simple setae on anterolateral margin. Scutellum and metanotum not visible from above due to curvature of amber, both seemingly gently convex when viewed from anterior or posterior. Propodeal triangle seemingly short, longer than metanotum but not longer than scutellum (estimated). Propodeal dorsal and lateral ridges rounded, lateral ridges slightly divergent; propodeal pit narrow; propodeum narrowed posteriorly. Legs slender; anterior basitarsal brush present and weak; protrochanter three times longer than wide; mesotrochanter twice as long as wide; mesotibial spine over half as long as mesotibia (Fig. 1); metatrochanter about as long as wide; metatibia swollen posteriorly. Basitibial plate not visible. Inner hind tibial spur pectinate, all teeth long; three teeth on right leg (not including the apex as a tooth); left leg with four teeth, first and third teeth shorter than second and fourth (Fig. 4). Wings hyaline; basal vein slightly distad of cu-v crossvein; first submarginal cell either equal to or just slightly longer than second and third combined (difficult to see due to wing folding); second submarginal cell not narrowed anteriorly; third submarginal cell roughly equal to second in length (along a median axis running basad to distad); anterior border of second submarginal cell along Rs longer than that of the third submarginal cell (Fig. 3). Marginal cell very broad basally and tapering to acute apex (Fig. 3). 2r-m slightly distad of 2m-cu, offset by about the width of a vein; 1r-m apparently

confluent with 1m-cu (difficult to see due to folding of wing along this region). All veins and stigma, black and strong.

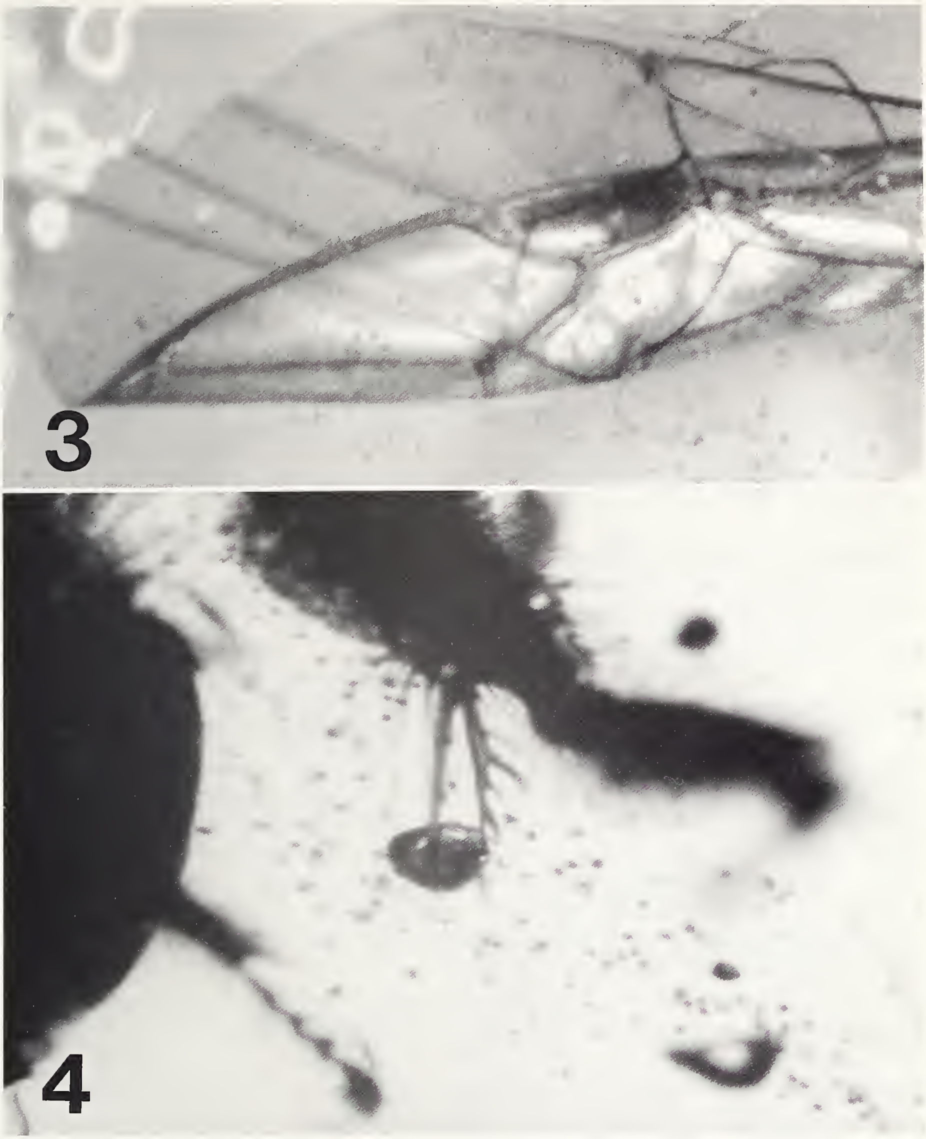
Integument of head and thorax brilliant metallic gold-green, except as indicated below and where presumably damaged by preservation. Clypeus and supraclypeal area finely granular with few scattered large granules. Distal margin of clypeus black and with few weak punctures. Remainder of face closely punctate, punctures separated by less than puncture width; integument between punctures finely granular. Punctures towards vertex becoming slightly smaller, but still close. Antenna black. Pronotum dark brown to black with metallic green highlights, lateral surfaces smooth and colored as on face. Mesoscutum closely punctate as head. Tegula light brown and semi-transluscent, posterior border darker brown. Scutellum and metanotum apparently sculptured as mesoscutum. Pleura roughened and closely punctate, except metepisternum which is finely granular. Propodeal triangle finely granular with short, weak striations along anterior margin (difficult to see). Propodeal dorsal and lateral surfaces imbricate or very finely granulose, impunctate. Legs dark brown to black with strong metallic green highlights. Metasoma dark green, generally impunctate. Tergum III apparently with very fine punctations basally and green color more apparent basally than on remainder of tergum. Sterna seemingly with same color and sculpturing as terga.

Face without pubescence, except a few simple, moderate length setae along distal margin of clypeus. Vertex with a few short, simple hairs. Pronotum and mesoscutum without visible pubescence. Scutellum and metanotum with numerous long hairs, some with short branches. Pleura with few scattered short to moderate length hairs. Propodeal dorsal and lateral surfaces with widely scattered hairs, all of moderate length. Scopa formed of long plumose hairs scattered on metafemur, on distal end of metatrochanter, and surrounding inner face of metatibia, those of tibia denser than on trochanter or femur; anterior and posterior faces of metatibia with stiff, simple hairs; similar hairs on basitarsus. Tergum I with moderately long, simple hairs on anterior face, remainder of tergum with few scattered short, simple hairs; hairs more numerous and longer on lateral margins. Terga II–V same as posterior half of tergum I. Sterna with hairs more numerous and longer than those on terga, hairs dispersed over entire surface and not concentrated on margins.

Preservation: The holotype specimen is wonderfully preserved, there being no destruction of the features by "Schimmel" (a whitish mold sometimes present on amber inclusions), and although there appears to be some very mild compression of the legs and head, none of it has obliterated any of the characteristics of the bee. The bee is folded at the waist such that the tip of the metasoma faces anteriorly (Fig. 1). The three right legs are stretched out away from the body and into the amber, while those of the left are positioned along the metasoma and beside the extended sting. A fracture plane runs through the amber, not fracturing the bee, across the head and back to the mesothorax (Figs. 1 and 2). The wings are folded or slightly crumpled, but extending away from the body posteriorly at an oblique angle to the line of the thorax (Fig. 1). Numerous small pollen grains are present in the scopa and scattered about the body in the amber (Fig. 1). The pollen has not been identified. A few small air bubbles are present in the amber near the specimen (e.g., a small bubble at apex of the clypeus in Fig. 2), but do not obscure the bee



Figs. 1–2. *Neocorynura electra* n. sp., holotype female. 1. Anterior view of bee's position in the amber and the fracture plane running across the bee. The mesotibial spine can be seen extending off of the right (left in the photo) mid-leg and appears somewhat foreshortened. The minute particles running from the lower right corner diagonally to the upper left are pollen grains (photo by D. A. Grimaldi, AMNH). 2. Enlarged view of the bee's face (photo by MSE).



Figs. 3–4. *Neocorynura electra* n. sp., holotype female. 3. Marginal cell of right forewing (photo by MSE). 4. Inner hind tibial spur of left leg (photo by D. A. Grimaldi, AMNH).

in any very significant way. Only the curvature of the amber obscures a clear view of some structures (e.g., the mesosoma as seen from above).

Holotype Female: Oligo-Miocene Dominican amber, deposited in the American Museum of Natural History.

Etymology: The specific name is derived from the Latin word *electrum*, meaning "amber."

Comments: *N. electra* can be easily separated from the other two amber augochlorines of the genus *Oligochlora*. *Oligochlora* lacks the anteriorly narrowed mesoscutum and distinctly carinate pronotal dorsal ridge present in *Neocorynura*. Aside from the generic characteristics, the acute marginal cell apex (Fig. 3), broad marginal cell base (Fig. 3), and sharp pronotal lateral angle can separate *N. electra* from both *Oligochlora eickworti* and *O. micheneri*. Additionally, both species of *Oligochlora* are fairly robust bees while *N. electra* is rather slender, resembling in this respect another amber halictine, *Eickwortapis dominicana* (Michener and Poinar, 1996). *Eickwortapis*, however, lacks a preoccipital carina and the anteriorly narrowed mesoscutum. This latter genus is likely to belong in the tribe Halictini, in which case the usual augochlorine characters would also differentiate *N. electra* from it, but tribal assignment of *Eickwortapis* has remained difficult due to an inability to adequately examine the female fifth tergum and the male seventh tergum in *E. dominicana* (see Michener and Poinar, 1996).

REMARKS

This is the fourth amber halictid species currently known, and the third from the tribe Augochlorini. As previously discussed by Engel (1996), the fossil augochlorines do little in helping to determine the overall age of the tribe as both *Neocorynura* and *Oligochlora* are not basal taxa.

No species of *Neocorynura* are known to occur in the Greater Antilles today (Moure and Hurd, 1987), although I have seen specimens of an unnamed species from St. Vincent and Trinidad (also noted by Eickwort, 1988; these specimens are in the National Museum of Natural History, Smithsonian Institution). The species from the Lesser Antilles is similar to *N. electra*, differing in the degree to which the pronotal lobe is produced, the width of the marginal cell, sculpturing of the propodeal triangle and metasoma, and overall body coloration. The extant species of *Neocorynura* are in need of taxonomic work and until such a study has been undertaken it is difficult to say whether *N. electra* is sister to the Lesser Antillean species and whether together they support a South American derivation of the West Indian augochlorine fauna. Given that no *Neocorynura* occur further North than Mexico, that the Mexican species available to me do not seem closely related to *N. electra*, and the restricted presence of the genus to the Lesser Antilles today, it seems unlikely that the West Indian fauna was derived from Mesoamerica. Eickwort (1988) suggested that the role of migration of Neotropical species via South America was not a strong component in making the West Indian halictine fauna. Considering the tribe Augochlorini alone, however, South America is probably the most significant source of migrants (see listing of taxa and their associations by Eickwort, 1988). *N. electra* apparently would also support such a relationship between South America and the West Indies for the augochlorines, while other source populations may be stronger contenders in creating the West Indian fauna for the sister tribe Halictini.

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A NEW SPECIES OF *ZENORIA* MULSANT FROM BRAZIL (COLEOPTERA: COCCINELLIDAE)

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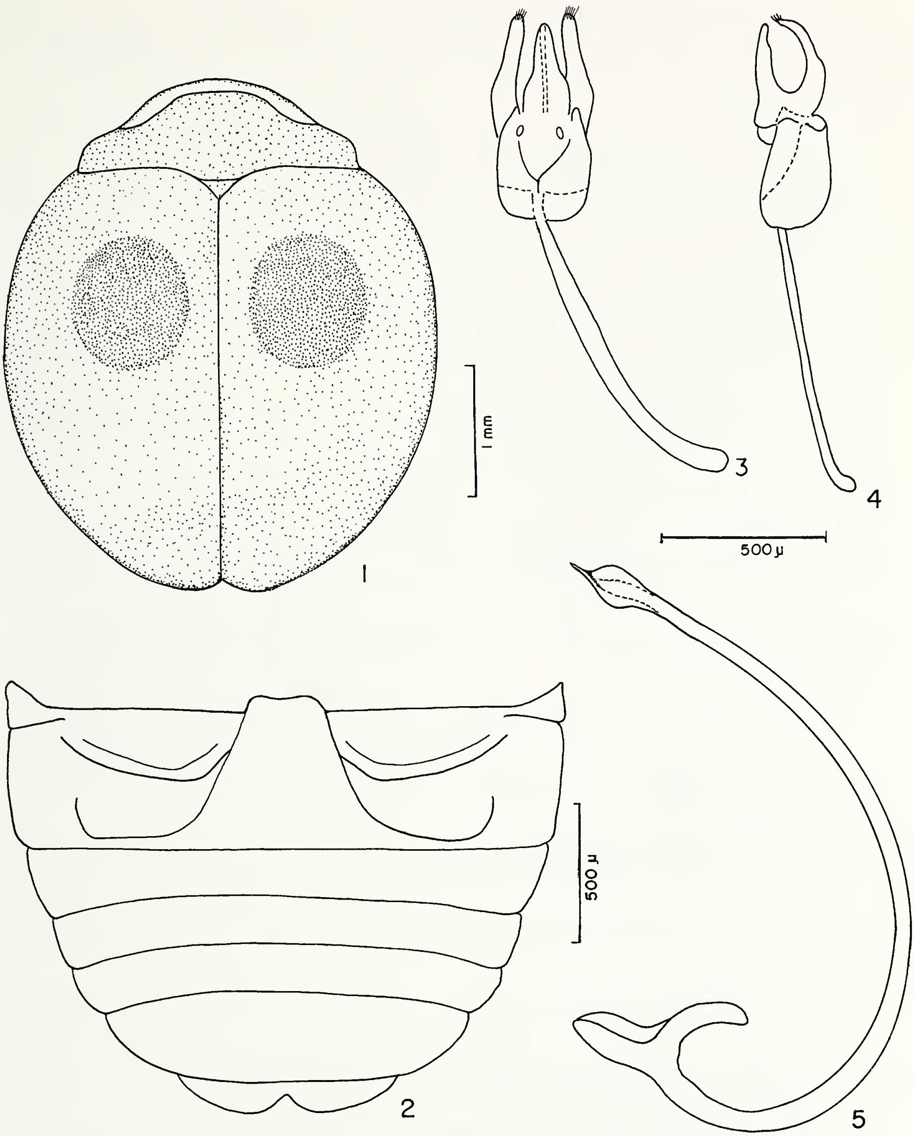
Abstract.—*Zenoria roberti,* new species from Brazil, is described and illustrated. This new taxon and five more (Gordon, 1972) are integrated into the existing key to species.

Gordon (1971) revised *Zenoria* and provided a key to the 25 included species. In 1972, he added five more species to the genus and indicated where they belonged in the key. Gordon (1978) included a color variant of one species and in 1981 synonymized another. In the present paper, the newest member of the genus is described and illustrated, and the key published by Gordon (1971) is expanded to include all known species. I am indebted to Dra.Vanda Helena Paes Bueno, ESAL/DFS who sent me the specimens collected in Lavras, Minas Gerais, Brazil. This species is named for Robert D. Gordon, the principal specialist on Coccinellidae.

Zenoria roberti, new species
(Figs. 1–5)

Holotype Male: Length 3.78 mm, width 3.23 mm. Form round, slightly elongate. Color predominantly black, covered with grayish white semidecumbent pubescence, average length of hairs 0.10 mm; anterior margin of pronotum, head and mouth parts, legs and abdomen pale yellow. Pronotum with punctures fine, separated by 1 to 4 times their diameter. Elytron with coarse punctures deep, separated by their diameter or less, each elytron with round discal spot, composed of black hairs (Fig. 1); margin of elytron explanate, feebly sinuate in lateral view; epipleuron horizontal, with inner carina reaching outer margin. Abdomen with postcoxal lines incomplete, extending downward nearly to hind margin of 1st sternum (Fig. 2). Genitalia with basal lobe shorter than paramere, broad at base, abruptly narrowing at basal third; sides parallel to rounded apex (Figs. 3, 4); paramere strongly curved downward, sipho sinuate before apex, tip acuminate (Fig. 5).
Female: Similar to male, except abdomen with the last sternum not emarginate and in sexual characters.
Variation: Length 3.50 to 4.00 mm; width 2.92 to 3.50 mm. Black pronotal area of male may be expanded nearly to lateral margin and head may have a black spot in the middle.
Type Material: Holotype male, Lavras, Minas Gerais, Brasil; IV-1993, Zacarias, M.S.col., Departamento de Zoologia, Universidade Federal do Paraná (DZUP). Paratypes, same data as holotype: 2 males, 3 females, United States National Museum of Natural History (USNM); 2 males, 4 females (DZUP); 1 male, Museu de Zoologia



Figs. 1–5. *Zenoria roberti* n.sp. Male. 1. habitus. 2. abdomen. 3. genitalia (ventral view). 4. genitalia (lateral view). 5. sipho.

da Universidade de São Paulo (MZSP); 1 female, S. Caraça (Engenho) 800 m, Minas Gerais, Brasil, XI-1961, Kloss, Lenko, Martins & Silva col. (MZSP).

Remarks: This species and *Z. patula* and *Z. serva* have similar genitalia: *Z. serva* and *Z. roberti* have the basal lobe shorter than parameres, but *roberti* has the paramere narrow at base; *Z. patula* has the basal lobe equal in length of paramere and

the apex of paramere nearly touching apically. The spot pattern on *Z. roberti* distinguishes it from all other members of *Zenoria*. See Gordon (1971) for genitalia illustrations of the *Z. patula* and *Z. serva*.

KEY TO SPECIES OF ZENORIA

The key to the species of *Zenoria* in Gordon (1971) is modified to include all known species.

1. Dorsal surface uniformly pale yellow or red, without markings 2
   Dorsal surface completely dark colored or with a dark color pattern 4
2. Ventral surface with at least the metasternum dark brown piceous . . . *Z. pallida* Gordon
   Ventral surface as pale as the dorsal surface 3
3. Length 4.00 mm; elytra yellowish red . . . . *Z. rodolioides* Crotch
   Length 3.40 mm; elytra pale reddish yellow . . . . *Z. pilosula* Mulsant
4. Elytron with 1 to 3 dark, longitudinal vittae 5
   Elytron with dark spots, rings, or entirely dark colored 6
5. Elytron with 1 dark, submarginal vitta, occasionally with a small median spot between vitta and suture (in part) . . . . *Z. subcostalis* Mulsant
   Elytron with 3 dark longitudinal vittae . . . . *Z. ratzeburgi* Mulsant
6. Elytron dark metallic purple; pronotum with anterior margin yellow . . . . *Z. purpurea* Gordon
   Elytron completely black or dark metallic green, only a trace of pale color present at humeral or apical angles on some specimens 18
   Elytron with varying color patterns, always with some yellow or red color 7
7. Elytron pale yellow with a small dark median spot; Peru (in part) . . . . *Z. variabilis* Gordon
   Elytron with color pattern not as above 8
8. Elytron yellow or red with a single dark submarginal band. 9
   Elytron with color pattern not as above 10
9. Length 3.45 mm; last sternum of female entire; Brazil . . . . *Z. circumcicta* Gordon
   Length less than 3.10 mm; last sternum of female strongly emarginate; Trinidad (in part) . . . . *Z. emarginata* Gordon
10. Elytra with a single black or metallic green spot occupying disc, outer margins pale yellow 11
    Elytra with color pattern not as above 16
11. Length 4.00 mm; discal elytral spot black . . . . *Z. delicatula* Weise
    Length less than 3.50 mm; discal elytral spot black or metallic green 12
12. Meso- and metasternum yellow; discal elytral spot metallic green 13
    Meso- and metasternum black, discal elytral spot metallic green or black 14
13. Length less than 3.10 mm; Panama (in part) . . . . *Z. schwarzi* Gordon
    Length more than 3.35 mm; Brazil . . . . *Z. annularis* Gordon
14. Discal elytral spot large, leaving only a narrow yellow ring around lateral border of elytra; Trinidad . . . . *Z. emarginata* Gordon
    Discal elytral spot small, leaving ⅓ or more of each elytron yellow; not known from Trinidad 15
15. Discal elytral spot black; male genitalia with basal lobe as long as paramere, a small tooth at apex of paramere; Peru, Bolivia . . . . *Z. discoidalis* (Kirsch)
    Discal elytral spot usually metallic green; male genitalia with basal lobe shorter than paramere, paramere with a tooth on inner margin before apex; Brazil . . . . *Z. crotchi* Gordon

16. Elytral pattern tricolored, marginal band yellow, middle band black or metallic green, median spot red 17
    Elytral color pattern not as above 19
17. Middle band of elytra black; Brazil . . . . *Z. tricolor* Nunenmacher
    Middle band of elytra metallic green; Panama (in part) . . . . *Z. schwarzi* Gordon
18. Elytra dark metallic green, most of lateral margin and a broad apical area and narrow sutural margin paler (in part) . . . . *Z. subcostalis* Mulsant
    Elytra pale yellow or with a black triangular spot on disc, or pale yellow with a large dark brown spot occupying most of elytra, broadly yellow post-medially and narrowly along suture, or with 3 brown areas on the elytron: a large, irregular area near the lateral border just anterior to the middle, a small, round area on the disc not touching the suture, and an irregular, transverse area on the apical third with touches on the suture; Peru . . . . *Z. variabilis* Gordon
19. Male with narrow outer margin or elytron yellow; female with last sternum strongly emarginate (in part) . . . . *Z. emarginata* Gordon
    Male with elytral margins not paler than rest of elytra; female with last sternum not emarginate 20
20. Epipleuron descending externally; female with last sternum carinate medially; Surinam . . . . *Z. carinata* Gordon
    Epipleuron horizontal; female with last sternum not carinate 21
21. Elytra dark metallic green, area of dark pubescence on disk not apparent 29
    Elytra black, with dark pubescence spot on each elytron or dark pubescence on disk very apparent 22
22. Length 4.70 mm or more . . . . *Z. stellaris* (Gorham)
    Length less than 4.70 mm 23
23. Length more than 4.10 mm, Peru . . . . *Z. paprzyckii* Gordon
    Length equal or less than 4.00 mm 24
24. Margin of elytron feebly, abruptly explanate, in side view slightly sinuate 25
    Margin of elytron broadly, gradually explanate, in side view strongly sinuate 26
25. Male genitalia with basal lobe longer than paramere; basal lobe wide at base . . . . *Z. roberti* n.sp.
    Male genitalia with basal lobe equal in length to paramere; basal lobe slender since the base . . . . *Z. revestita* Mulsant
26. Male genitalia with basal lobe shorter than or as long as paramere 27
    Male genitalia with basal lobe longer than paramere 28
27. Male genitalia with basal lobe equal in length to paramere; length 3.90 mm . . . . *Z. patula* Gordon
    Male genitalia with basal lobe shorter than paramere 30
28. Paramere with width base, not inflated with rounded apex . . . . *Z. serva* Gordon
    Paramere constricted at base, inflated, with curved and pointed apex *Z. dozieri* Gordon
29. Length 3.30 mm or less; male genitalia with basal lobe wide at base, concealing parameres in ventral view, gradually evenly narrowed to a bluntly rounded apex . . . . *Z. nigra* Gordon
    Length 3.45 mm or more; male genitalia with basal lobe narrower at base, not concealing parameres in ventral view, narrowed from middle to a bluntly rounded point . . . . *Z. similaris* Gordon
30. Length 4.30 mm or more; mesosternum black, metasternum yellow . . . *Z. major* Crotch
    Length less than 4.10 mm; and metasternum black 31
31. Pronotum with median basal projection black 32
    Pronotum all black except anterior margin yellow 33

32. Male genitalia with basal lobe slender, parallel-sided; parameres inflated, constricted at base and narrow at apex . . . . *Z. nigricollis* Gordon
    Male genitalia with basal lobe triangular, parameres not inflated, not constricted at base 34
33. Male genitalia with basal lobe shorter than paramere, with apex rounded . . . . *Z. formosa* Gordon
    Male genitalia with basal lobe equal in length to paramere, with apex slightly sharp . . . . *Z. linteolata* Mulsant
34. Male genitalia with basal lobe shorter than paramere with apex rounded . . . . *Z. peruviana* Gordon
    Male genitalia with basal lobe equal in length to paramere with apex flattened . . . . *Z. flavicollis* Gordon

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NOTES AND COMMENTS

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THE OCCURRENCE OF *JUNONIA EVARETE* (LEPIDOPTERA: NYMPHALIDAE) AND *ACROMYRMEX STRIATUS* (HYMENOPTERA: FORMICIDAE) ON *PAEPALANTHUS POLYANTHUS* (ERIOCAULACEAE)

As part of a larger investigation comprising the population dynamics of *Paepalanthus polyanthus* (Bong.) Kunth (Eriocaulaceae), two main herbivores were recorded: *Junonia evarete* (Lepidoptera: Nymphalidae) and *Acromyrmex striatus* (Hymenoptera: Formicidae).

This study was developed on sand dune slack at Joaquina Beach, Florianópolis, Santa Catarina State, Brazil (27°36′S; 48°27′W), where 9186 individuals of *P. polyanthus* were followed and recorded in 3 permanent plots of 5 × 5 m, from December, 1986 to December, 1991. During that period the maximum monthly means of temperature ranged between 24°C and 26°C throughout summer months (December to March), while the minimal monthly means ranged from 14°C to 17°C in June and July. The highest pluvial levels were recorded during summer and spring, with hydric deficits occurring in 1988 (the most severe one), 1989, and 1991, particularly at the end of autumn and beginning of winter. *Paepalanthus polyanthus* is a monorcarpic species, dying after reproduction. Reproduction can occur from the second year of life on, though, generally, it occurs later (Castellani et al., in preparation). The flowering begins in July with peak in November and fructification occurs from September to January (d'Eça Neves and Castellani, 1994). In these sites, this population experienced a density reduction from December, 1986 to May, 1989 due to post-reproductive mortality of a great proportion of plants and low recruitment of seedlings. Such recruitment occurred expressively only in June, 1989 and April, 1990 (Fig. 1), favored by periods of high pluviosity during summer and the beginning of autumn (Castellani et al., in preparation).

Damage caused by *J. evarete* occurred from December, 1986 to June, 1989, a period during which the population of *P. polyanthus* was predominantly constituted by established plants of large and intermediate sizes of rosettes (Fig. 1).

Two basic patterns of herbivory were distinguished: caterpillars up to 2 cm make scrapings that cause lesions to the superficial layer of the leaf, while caterpillars over 2 cm are chewers. The caterpillars attack tender leaves specially the intermediate and the central apical ones. Herbivory does not injure the apical meristematic portion. The plants usually survive and produce new leaves in their normal pattern of growth.

In the surveys, the highest percentages of plants damaged by caterpillars of *J. evarete* occurred during autumn, in March and June, 1987, May, 1988, and April/May, 1989 (Fig. 1). From September to December, 1987 and 1988, months of reproduction of the host plant, the percentage of vegetative plants exhibiting lesions

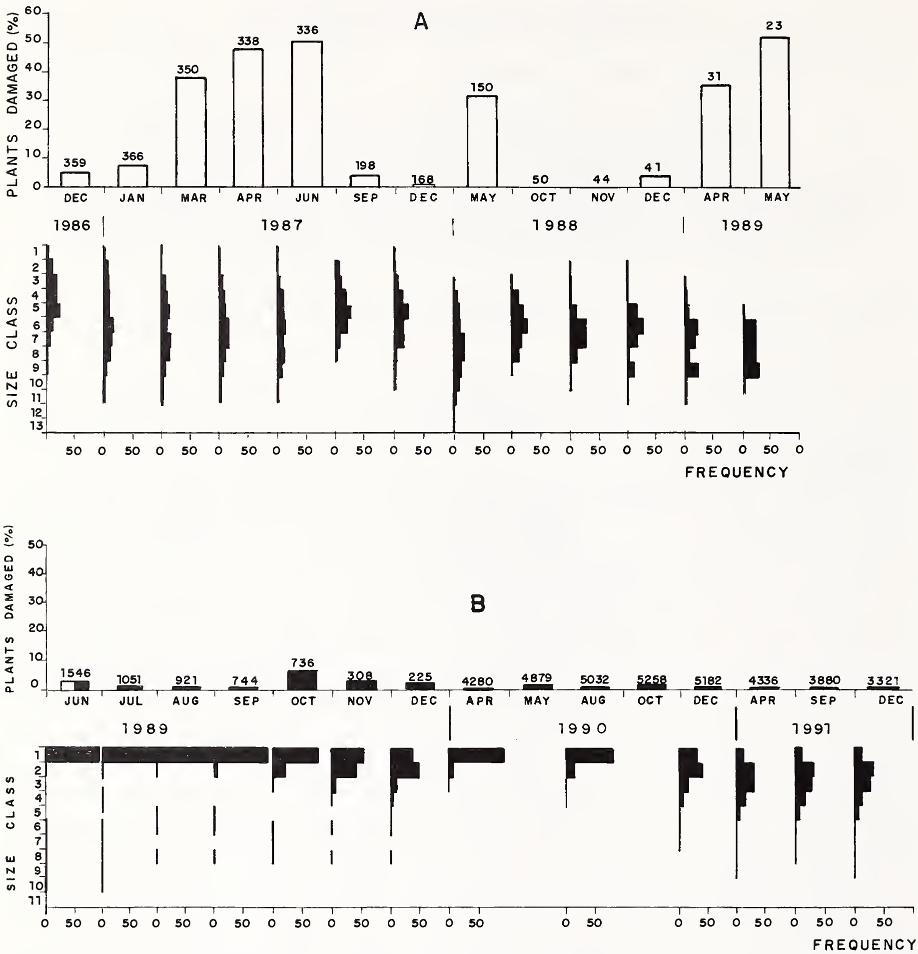

Fig. 1. Percentage of plants of *Paepalanthus polyanthus* damaged by *Junonia evarete* (open areas) and by *Acromyrmex striatus* (shaded areas) from December 1986 to May 1989 (A) and from June 1989 to December 1991 (B). The number of vegetative plants alive in the 3 permanent plots of 25 m^2 are indicated above the bars and their size distribution along these years are represented in the figure below. The size class is based on the diameter of foliar rosette and is: 1 (0–2.9 cm), 2 (3.0–5.9 cm) . . . 13 (36.0–38.9 cm).

caused by *J. evarete* was low (Fig. 1). These caterpillars are not found on reproductive plants which show a dry foliar rosette. We suggest that the utilization of leaves of *P. polyanthus* by *J. evarete* matches the period during which the plant population offers large amounts of tender leaves. The absence of herbivory by *J. evarete* during the period when the population of *P. polyanthus* was predominantly constituted by young individuals (from June, 1989 to December, 1991) might be related to the small size of these host plants at such sites. Crawley (1983) refers to

the small size of plants as one of the factors that a plant may be unusable by its herbivores.

According to Otero (1986) and Brown-Jr. (1992), *J. evarete* occurs in sunny open areas and their larvae can feed on leaves of *Stachytarpheta* sp. (Verbenaceae), *Laguncularia* sp. (Combretaceae) and many ruderal plants. In the dunes system studied, *Junonia evarete* seems to be a herbivorous specialist on *Paepalanthus polyanthus*. In the area under observation another 60 species of plants were recorded throughout the years, being that none of those plants were utilized by caterpillars of *J. evarete* (see Castellani et al., 1995 for details of list of species). In those dunes, there was no recording of Combretaceae species, and among Verbenaceae there was the occurrence of *Lantana camara* and *Vitex megapotamica,* on which such species of Nymphalidae were never observed. Ackery (1984) does not mention Eriocaulaceae among the host plants for caterpillars of Nymphalidae. So this might be the first record of herbivory of *J. evarete* - a polyphagous species - for this plant family.

The role of the herbivory by *J. evarete* as a factor of mortality for *P. polyanthus* plants did not seem significant in 1987 and 1988. During these two years the majority of the plants was affected to a maximum of 5% of its foliar basal area (Table 1). The rate of herbivory was estimated visually, and the percentage of damaged green foliar area was quantified. In 1987 all damaged plants that died were small (size classes from 1 to 4), being that 8 of these presented foliar lesions under or equal to 20%. Such mortalities might not be due to herbivory but be just the mirroring of the higher risks presented by small sized individuals (Castellani, 1990).

In 1988 no damaged plant died. As in 1987, plants which suffered 60% to 80% of herbivory reestablished part of their foliage or underwent reproduction.

In 1989 larger lesions of herbivory were observed, along with an increase in the proportion of plants which died without reproduction.

Dirzo (1985) revises experiments of stripping of leaves in which only those plants submitted to maximum rates of foliar loss (100%) tend to die. However, the responses to herbivory tend to differ from each other due to density, to the abiotic conditions of plant development (e.g., luminosity and hydric availability) as well as to the age of plants (Crawley, 1983, 1988; Dirzo, 1985). Stephens (1971 *apud* Begon et al., 1986) argues that repetitive foliar damages in subsequent periods might have more drastic consequences than just a high damage rate of just one episode of herbivory.

In 1989, in addition to the fact that the herbivory rate of *J. evarete* was more marked, several individuals were damaged in the following years. The higher level of damage in 1989 could be related to the drought stress experiencied in 1988 (winter/spring), once stressed plants could be more herbivored in function of increased availability of amino-acids or a low ability on the part of stressed individual plants to defend themselves (Crawley, 1988). However, that doesn't explain if herbivory is the main or the only cause of such deaths. Other factors as the proper hydric shortage, the greater microclimatic rigor, and the aging of those individuals might also be acting upon mortality (Castellani et al., in preparation).

The main agent responsible for foliar lesions on young plants of *P. polyanthus* was the leaf-cutter ant *Acromyrmex striatus.* The highest percentage of plants showing damage caused by this ant was recorded in October, 1989. During that month

Table 1. Number of plants (N) of *Paepalanthus polyanthus* damaged in different degrees by caterpillars of *Junonia evarete* and their fates, death (D), reproduction (R) or survival (S), in each year of study.

Leaf area eaten (%)	Dec 1986–Dec 1987				Jan 1988–Dec 1988				Jan 1989–Dec 1989			
	N	D	R	S	N	D	R	S	N	D	R	S
1–5	109	4 (3, 7%)	45	60	31	0	25	6	3	0	1	2
6–10	35	2 (5, 7%)	28	5	8	0	5	3	3	1 (33, 3%)	1	1
11–20	36	2 (5, 5%)	21	13	4	0	3	1	1	1 (100%)	0	0
21–30	26	0	19	7	2	0	1	1	3	1 (33, 3%)	2	0
31–40	9	1 (11, 1%)	8	0	1	0	1	0	5	0	4	1
41–50	16	1 (6, 2%)	5	10	—	—	—	—	1	1 (100%)	0	0
51–60	5	2 (40, 0%)	1	2	—	—	—	—	—	—	—	—
61–70	6	0	3	3	1	0	1	0	2	1 (50%)	1	0
71–80	1	0	1	0	1	0	0	1	1	1 (100%)	0	0
81–90	—	—	—	—	—	—	—	—	—	—	—	—
91–100	1	1 (100%)	0	0	—	—	—	—	—	—	—	—
Total	244	13	131	100	48	0	36	12	19	6	9	4
		5, 3%	40, 9%	53, 7%			75, 0%	25, 0%		31, 6%	47, 4%	21, 0%

these ants were observed forming large tracks of foraging in one of the permanent plots which, on that date, presented the highest density of seedlings of *P. polyanthus*.

Fowler et al. (1986) made a distinction between leaf-cutter ants of forest habitats and those of open habitats in relation to the kind of vegetation used as a substratum for the fungus on which they feed. The leaf-cutter ants of forest environments use almost exclusively the dicotyledons, while the ones of open environments use dicotyledons, grasses or both. These authors refer to the *A. striatus* using grasses, an observation which seems to agree with the herbivory in young individuals of *P. polyanthus*, a monocotyledon which forms rosettes with linear-lanceolated leaves. However, *A. striatus* was seen using leaves and/or flowers of *Andropogon selloanus* (Gramineae), *Centella asiatica* (Umbelliferae), *Stylosanthes viscosa* (Leguminosae), and *Tibouchina urvilleana* (Melastomataceae), which occur neighbouring *P. polyanthus* in the sand dune slacks. The relation of this species of leaf-cutter ant to *P. polyanthus* seems to have an opportunistic character, and its absence preceding June, 1989 might be related to the presence of caterpillars and feces of *J. evarete*.—*Tania Tarabini Castellani, Karla Zanenga Scherer, Lucir Maria Locatelli, Benedito Cortês Lopes, Departamento de Biologia, Centro de Ciências Biológicas, Universidade Federal de Santa Catarina, C.P. 476, Florianópolis, Santa Catarina, Brazil, CEP 88010-970.*

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THREE RARE GOMPHIDS FROM THE LOWER CONNECTICUT RIVER

Three gomphids new to the Connecticut state fauna (Garman 1927) were discovered on sandy beaches of the Connecticut River in Middlesex County, Connecticut: *Gomphus fraternus* (Say), *Stylurus amnicola* (Walsh), and *Stylurus spiniceps* (Walsh). All three are rare in New England and there is but little known about the biology of the two *Stylurus* species (Garman, 1927; Howe, 1918; Walker, 1958).

Sandy beaches at Cromwell and Portland were visted three to four times a week from 5 June until through 18 August, 1995; on average a 200 to 300 m stretch of beach was walked continuously for a period of five hours during a visit. At both sites the river is broad (ca. 500 m) and without riffles. The beaches, though more than 25 miles from the ocean, are tidal with daily water levels often fluctuating as much as 1 m. Small waves continually influence the shoreline. Sands are fine and compacted, grading to mud and clay in places.

Gomphus fraternus was observed on the first visit (5 June); the last individual noted was a worn female on 24 July. Over the first few weeks 4–12 individuals were seen per visit. Adults landed on sandy areas along the river, well above the current water level, but away from the shoreline vegetation.

Eclosing and teneral adults of *Stylurus* were first found in early July at the Portland site. Both *Stylurus* species were initially thought to be emerging individuals of *Gomphus fraternus,* so little data was collected until the 19th of July, when we realized our mistake. The next day we arrived by 0830 hr and walked a 200 m section of the Portland beach until 1600 hr. Five individuals of *Stylurus spiniceps* and one of *S. amnicola* emerged between 1230 and 1430 hr, roughly corresponding to the period of low tide on that date. Additional emergence data are given in Table 1. On most sunny days in July and early August we could count on seeing 4 to 6 individuals emerging; the most we saw on any day was 10. We observed emergences between 1000 and 1700 hr, with activity peaking during tidal lows that were accompanied by sun. Exuviae were collected from beaches on 20 July, 1 August and 4 August, 1995, primarily from the wrack line: these included 32 *S. spiniceps* and 7 *S. amnicola.* In the center of the Portland beach, we found 1 or 2 *Stylurus* exuviae per liner foot of shoreline (on 20 July). Where the beach narrowed, exuviae were found among the roots of shoreline shrubbery.

Eclosing larvae left distinctive zipper-like tracks which extended to or above the wrack line, although the occasional individual eclosed closer to the water. We found

Table 1. Recorded *Stylurus* emergences from Portland. Numbers reflect all individuals encountered on 20 and 31 July and 1 and 14 August. On other dates numbers reflect only the collected sample of eclosing individuals—most individuals were not collected or disturbed.

Date	*Stylurus spiniceps*		*Stylurus amnicola*		*Stylurus* spp.
	Male	Female	Male	Female	
20 Jul	3	2	1		
23 Jul	2				
24 Jul	1				
27 Jul	1				
31 Jul	1	1	1		
1 Aug					4
4 Aug		1			
14 Aug	1				

many aborted emergence "trails," half-consumed larvae, and older damaged exuviae in the beach wrack which collectively indicated the population was under considerable predation pressure. On 23 July, a gray catbird (*Dumetella carolinensis*) was seen eating an emerging individual, while two others worked nearby beaches in a sandpiperlike fashion—of six *Stylurus* trails found on this date, bird tracks were associated with all five where we were unable to locate an eclosing or adult dragonfly. Beak marks were associated with the terminus of three aborted trails (including the *Stylurus* larva that was observed being taken).

A stereotyped eclosion process was documented for approximately 15 individuals. Typically, they crawled onto the beach about 0.5 m to 0.75 m and paused for 5 to 10 min and then proceeded another 1–2 m before again stopping for a period of 10 min (N = 10). During this second quiescent period larvae drew the tip of the abdomen over the body and excreted a single drop of fluid over the thoracic midline—this behavior was repeated three or four times in all 15 of the emergences we witnessed. The larvae then crawled farther shoreward, onto drier sand or vegetation, where they completed their emergence. During the first 10 min of eclosion the teneral splits open the larval shell and pulls its head and thorax free. Once completely free from the exuviae, it invariably takes only 5 to 6 min to fully expand the wings (N = 15). The entire process takes only 30 to 40 min. Minutes after expansion of the wings, adults are able to fly short distances (1 to 5 m) but do so only if disturbed. After 60 to 75 min individuals are capable of sustained flight into nearby vegetation (N = 10).

Over the five-week period when *Stylurus* was known to be on the wing, virtually no activity was noted over the water close to shore (the river is close to 200 m wide at Portland). A single individual which may have represented *S. spiniceps* was seen at 0930 hr over the river on 20 July. Many individuals of a gomphid-like dragonfly were noted to perch in treetops along the river, at heights of more than 15 m. We returned to the site twice in late afternoon and remained through dusk to determine if adults were crepuscular as suggested by Kellicott (1899). No individuals were seen over the river or in the trees on either visit.

Approximately ten (non-emerging) *Stylurus* larvae were seen relocating to deeper water during very low tides. Tracks indicated that several of the larvae had been

crawling across the river bottom, but upon exposure at the water's edge, had crawled or swam in short bursts into deeper water. All buried themselves in fine sands, in just a few seconds, just one to two feet from (the low tide) shore.

Teneral adults were caged and brought into the laboratory and held for up to two weeks. Initially we fed newly emerged adults margarine on a wooden stick by depositing small globs between their mandibles—only about half accepted this diet. Better success was achieved when adults were hand-fed laboratory-reared crickets. Adults also imbibed water that was misted into their screened enclosures daily. Adults lived up to two weeks, when our efforts to maintain them were terminated.

All three are species of sandy sections of large rivers (Walker, 1958; K. Soltesz, personal communication). Although these gomphids are broadly distributed in the East, they tend to be local and rare. In New England, *Stylurus spiniceps* was known only from a few sites in New Hampshire and Massachusetts; the other two were known only from the latter state (Howe, 1918; White and Morris, 1973; Carpenter, 1991; S. Roble, personal communication). All are ranked as "S1" taxa by the Massachusetts Natural Heritage and Endangered Species Program, i.e., they are species believed to be very rare, with five or fewer occurrences within the state.

The dragonfly fauna of Connecticut was monographed in 1927 by Garman, and has been relatively well collected since. The discovery of three clubtail species—new to the state fauna—on a single beach of the Connecticut River is testimony to the uniqueness and importance of the sandy beach–sandbar ecosystem of the river. No doubt, these beaches are home to additional regionally rare areniphilous species (e.g., asilids, therevids, and ground-nesting Hymenoptera), and every effort should be made to protect these sites from development, heavy foot or vehicular traffic, and pollution—*David L. Wagner, Ecology and Evolutionary Biology, University of Connecticut, Storrs, Connecticut 06269, Denise M. Simmonds, The Connecticut Nature Conservancy, 55 High Street, Middletown, Connecticut 06457, and Mike C. Thomas, 206 Skyview, Cromwell, Connecticut 06416.*

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BOOK REVIEWS

J. New York Entomol. Soc. 103(3):337–339, 1995

THE KING OF THE ANTS

A New General Catalogue of the Ants of the World.—Barry Bolton. 1995. Harvard University Press, Cambridge, Massachusetts. 504 pages.

What can you say about such a volume? It is not a coffee-table book, such as Bolton's last volume, produced in similar oversized format by Harvard University Press (Bolton, 1994). But it adds up to something even more exciting: the holy triad of ants research. The two Bolton volumes and Hölldobler and Wilson (1990) mark indeed the culmination of ant research, do they not?

The Insect Societies, written almost twenty years ago by Ed Wilson (1971) has probably to be considered to be the real turning point in the study of ant behavior. It was the first modern synthesis and foundation of what followed, the masterly compilation by Hölldobler and Wilson (1990) in *The Ants.* That volume however has to be considered a *status quo* of an evolutionist's view of what was known in the early nineties in terms of ants, rather than a new approach in the field. At that time it was also of importance for its more than 600 included references, a number which has now to be compared with over 18,000 references included in *FORMIS,* available on the Internet today (Porter, 1996).

The *Identification Guide To The Ant Genera Of The World* (Bolton, 1994) is very attractive not only to the user, but to a wider audience, who enjoy scanning electron microphotographs of the weirdest creatures you can (almost) imagine. It is also the first comprehensive documentation of most of the extant ant genera published in one volume, an effort initiated with an eclectic collection ranging from cartoons to the most artistic drawings of ants by Hölldobler and Wilson (1990).

Finally, the *New Catalogue To The Ants Of The World* does not represent something sensually very attractive such as the identification guides or the color plates and the black and white illustrations in *The Ants*—but who likes a telephone directory for other than getting the right number, giving you access to whatever you always wanted to have? It is a unique piece of handicraft and patience. For that, more than 70 years had to pass since the last catalog of the ants of the world was finished by Emery. And who might have done such a master's job other than Barry Bolton?

Barry Bolton is for me the archetype of myrmecologist and taxonomist. As is typical for a myrmecologist, living ants play an integral part in your daily life, to such an extent that one's sweetheart has to accept colonies of ants in plaster nests among the stacks of freshly ironed shirts. As taxonomist, he represents the perfect civil servant, which once built up one of the cornerstones of the long lasting success of the Empire. He got his job to describe and curate ants at the British Museum (Natural History) in the early seventies, and he has done it in the most efficient way ever since.

One day, it was ten past ten in the morning at the tea table on the third floor in the entomology building, and after Barry finished complaining about the bad appearance of the English soccer team, he mentioned the sheer impossible, that one of the aims in his life is not to forget anything. On another occasion he mentioned casually that he gave up some years ago translating texts written in hieroglyphs into modern English for the British Museum at Bloomsbury. This just reminded me, that he has another major catalog sitting on his shelves—an unpublished dictionary of hieroglyphs. But that is only part of the story. He seems to know by heart all the scriptures of the extinct Middle Eastern languages.

This sense, almost obsession, of order, and a very deep love for ants must have driven him to complete the catalog of the world, despite a very stormy period along its way, i.e., the transformation of the British Museum (Natural History) into **The** Natural History Museum, coupled with confusing attempts to re-orient the research. Suddenly, the young elite researched the diversity of life by asking the old elite about intelligent guesses, about what is out there, thereby not bothering to touch any of the millions of specimens in the collection. Or the newly created Biodiversity Ambassador was trying to extract funds from conservation oriented money to improve the museum's financial situation, forcing people into saleable projects rather than those at which they were best—revisions at a global level. Barry kept working on the catalog, every day up to the last one until two hours before he left for home, and you should not have tried to get in touch with him during this time but the five 'smoking' minutes on the little stairs leading up to the roof on the *spirit building.* This disciplined working attitude was always his, even out in the jungle. During his time as participant in the Gunung Mulu expedition in 1977, he was outstanding two ways: in scrupulously examining every square chosen a few yards outside the base camp (i.e., destroying the whole thing completely), and to be the main sink of the rare beer stock, stimulating him to entertain the whole crowd out there in the bush by telling outrageous stories and singing bawdy songs later in the evenings (Hanbury-Tension, 1992). He must have felt very depressed, when he later learned that all the vials of ants collected in this project were crushed by a lorry on the way back to London.

It must have been the regular two pints of cider in the evening which helped him get through this monstrous task of cataloging all the 9,944 ant species (numbers are crunched in Bolton, 1995), not including subspecies, varieties and the wealth of infrasubspecific taxa, being unavailable names by nomeclatorial rules. If that itself seems to be a full time job, he added during this time most valuable numbers of new morphological characters in numerous revisions, which changed among other things the way the phylogeny of ants is seen now (for a complete list of his systematics papers see the references in the catalog itself). Finally, he seemed to be insatiable in reading literally tons of manuscripts every year and helping to identify ants, with greater pleasure the rarer they were, thus earning the high esteem of his colleagues.

Barry Bolton created his catalog. It is concise, complete and doubtless most reliable, giving all the necessary information if you deal only with the nomenclature of any of the species. One might have different views on such subjects however. In his fantastic effort to get even the most unusual references and with it the date of publication, he could have added at the same time more information that he came

across to the catalog, such as references to the biology or the distribution of the ants, even if it would have been only the name of the country. This would have expanded the book substantially, but who else gets the chance (and the personality) to do such a compilation again? Also, there is no index to the species and other taxa, and electronic publication and dissemination of the catalog as such, or as database are not available. One might argue that Barry Bolton and Harvard University Press sell the catalog at a (too) high price for a developing nation's scientist. I would have preferred this kind of information available on the Internet, especially because the whole catalog was paid for by the taxpayer anyway. No matter, for it is Barry Bolton who made the catalog, and he merits the highest recognition for it.

I am sure, that the age of the ants has finally been launched by this oeuvre. For the first time, ants will really be available for biodiversity and conservation studies: ants the rulers of global biodiversity, wrangled by the king of the ants, and explained by the lord of the ants, Ed Wilson.—*Donat Agosti, Dept. of Entomology, American Museum of Natural History, Central Park West at 79th St., New York, New York 10024.*

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The Tent Caterpillars.—Terrence D. Fitzgerald. 1995. Cornell University Press, Ithaca and London. 338 pages, 8 color photographs, 38 black and white photographs, 101 drawings. $37.95 (cloth).

Consider the various aspects of lepidopteran biology that have drawn the fascination of scientists and layman alike: The sheer diversity of the group; its incredible array of life histories and hostplant associations; coevolutionary curiosities such as mimicry complexes; and, of course, their often charismatically showy coloration. Moth larvae have also been responsible for some of the most costly challenges facing foresters, farmers, orchardists, and horticulturalists. Indeed, the Lepidoptera are perhaps unique in having captured simultaneously the fancy of poets and the wrath of would-be pest control efforts. In this volume, the latest in the Cornell series in Arthropod Biology and the last to be edited by the late George C. Eickwort, T. D. Fitzgerald synthesizes a vast literature devoted to the biology of tent caterpillars

(*Malacosoma* spp.) from ecological, evolutionary, behavioral, physiological and applied perspectives. In summarizing over 400 references as well as his own impressive research program devoted to the North American tent caterpillars, the author seeks to draw together information for one of the few lepidopteran groups better known for the biology of their caterpillars than as adult moths; caterpillars that, in the author's words, "sit at the pinnacle of caterpillar social evolution" (p. 27).

"The Tent Caterpillars" begins with a brief review of the life history and taxonomy of *Malacosoma* (Chapters 1 and 2). The bulk of Chapter 2 comprises an articulate, highly speculative, but nonetheless intriguing discussion of the possible factors mediating the evolution of tent caterpillar communal behavior, a discussion that resurfaces throughout the book, and to which I shall return below. Chapters 3 and 4 cover the anatomical and physiological features of larvae and pupae (Chapter 3) and of adults and egg masses (Chapter 4). The next four chapters skip from the ecology of caterpillar-hostplant interactions (Chapter 5), to the behavioral ecology of larval aggregation and foraging (Chapter 6), tent building (Chapter 7); and, finally, to interactions with predators (Chapter 8). Chapters 9 and 10 cover the ecology of tent caterpillar outbreaks, their economic impact and management, and Chapter 11 concludes the book with a how-to section devoted to classroom and laboratory experiments with maintained colonies.

One of this book's highlights is the review of larval biology in Chapter 3. The numerous figures in this (and the subsequent) chapter, including SEM's, figures of anatomical systems (mostly redrawn), and photographs, are well-labelled, referenced, and explained to the extent that this section could well serve as an excellent general primer on lepidopteran larval morphology and biology. While I was already familiar with much of the ecological and empirical work on *Malacosoma* discussed in later chapters, I was very impressed with the range of basic anatomical and physiological studies that have been conducted on *Malacosoma* caterpillars. I was fascinated, for example, to learn that test caterpillar larvae are the only immature insects known to exhibit Tyndall colors, and the only insects in which the Tyndall effects are cuticle-derived (p. 48).

From the outset, the author emphasizes one of the most fascinating aspects of larval *Malacosoma*: their communal behavior. As he notes, there are few other caterpillars exhibiting the complex communal behavior of *Malacosoma,* and none whose overall biology has been so extensively studied. Throughout, Fitzgerald presents fascinating accounts and exhaustive syntheses of an immense number of published studies, many of which he co-authored. Most of these works have been strictly ecological in nature. Although Fitzgerald devotes substantial attention to the evolution of social behavior (most often citing E. O. Wilson's seminal texts on insect societies (1971) and sociobiology (1975)), much of his discussion is undercut by an avoidance of a phylogenetic perspective. If I have one general criticism of the book, it is that much of Fitzgerald's numerous evolutionary discussions could have been enhanced by a more macroevolutionary bent. While Fitzgerald appears to pay lip service to phylogenetic systematics, his treatment of both taxonomy and evolutionary scenario-testing suffer from a poorly articulated phylogenetic platform; and to the extent that the systematics of *Malacosoma* specifically, and lasiocampids in general, are covered at all, they are given rather short shrift in terms of the context they will no doubt provide in future studies of the evolution of tent caterpillar sociality. The

reader is referred to the taxonomic revisions of Franclemont (1973) and Stehr and Cook (1968), and summaries of alpha-taxonomic revisions of those authors are presented early on in Chapter 2. Granted, as with most lepidopteran groups, the systematics of lasiocampids have not been recently worked, and reproductions of color plates representing various *Malacosoma* adults and larvae may have seemed redundant to the author given their coverage in the Moths of North America fascicle. However, the four pages or so of text devoted to *Malacosoma* taxonomy, the tabular summary of valid trinominals on pages 8–10, the single paragraph devoted to "phylogenetic considerations" immediately thereafter, leave the impression of dispensing with systematics as quickly as possible so as to proceed to other, perhaps better studied aspects of ten caterpillar biology. Given that the book includes several color plates depicting larval aggregations, tents, and predation by a vespid, one wonders why the effort was not made at least to figure the six North American species of *Malacosoma.*

The avoidance of systematics detracts from the author's discussions of the evolution of social behavior as well. Although, again, lasiocampid systematics are clearly not well enough resolved to support macroevolutionary scenario-testing, some discussion of the potential for such work is warranted. A growing body of literature suggests that the evolution of sociality can and should be addressed phylogenetically, and that various behavioral attributes of organisms may be phylogenetically conservative. The author does make note of Sillén-Tullberg's early work (Sillén-Tullberg and Bryant, 1983) on the role of natural selection in the evolution of aposematism (p. 203), but not her more recent (and controversial) discussions of the utility of phylogenetics in addressing the evolution of gregarious behavior and aposematism in butterflies (Sillén-Tullberg, 1988) and in tree-feeding moths (Sillén-Tullberg and Hunter, 1996). Neither Carpenter's (1989) application of phylogenetics to the evolution of sociality in vespid wasps, nor the potential for coding behavioral characters such as those associated with nest-building are mentioned. Generally, Fitzgerald ably summarizes various views on the evolution of sociality, but rarely if ever critiques or explains the limitations of the kinds of data used in support of those views (but see p. 136).

Relatedly, I found Fitzgerald's recourse to natural selection as the primary agent mediating the distribution of various tent caterpillar life history parameters somewhat trite. The author often glibly invokes natural selection and adaptation to explain cluster oviposition (p. 80), the timing of larval eclosion (p. 93), synchronous foraging (p. 144), tent architecture (p. 148), and the evolution of warning coloration (p. 203) with little or no discussion of the potential for phylogenetic information to illuminate the various hypotheses and speculations. While the author devotes considerable text to describing the phenology of larval eclosion and feeding, and the climatic and ecological forces presumed to have selected for those phenologies, no direct mention is made of Feeny's phenological window hypothesis, nor, again, of the possibility of phylogenetically conservative seasonal histories.

For the most part, The Tent Caterpillars succeeds in covering a great deal of ground. As with any work dedicated to the holobiology of any organism(s), it is necessary to present a fair amount of background information, if only as context from within which to highlight the uniqueness of the organisms in question. In the chapters devoted to the ecology of herbivore-hostplant interactions and of outbreak

species such as *Malacosoma,* Fitzgerald switches adeptly from general discussions providing background on the nutritional ecology and hostplant chemistry to the specific mechanics of tent caterpillar feeding biology. Fitzgerald provides an able review of the various quantities typically used in nutritional ecology studies (pp. 95–96), and a superb synthesis and critique of the literature devoted to the nutritional ecology of *Malacosoma* in particular. Perhaps more background information might have better highlighted some of the interesting aspects of the biology of *Malacosoma* and of outbreak species generally. Fitzgerald does cite Nothnagle and Schultz (1987), who cataloged life history parameters common to many outbreak species, but again much of the discussion devoted to the ecology of *Malacosoma* outbreaks relies heavily on speculations based on the "ghost of natural selection past." Such discussions might well have been enhanced by emphasizing, for example, that many of the more notorious outbreak pests belong to families of moths that do not feed as adults. By the same token, Fitzgerald's discussion of nutritional ecology would be enhanced by a more rigorous discussion of the relevance of generalist/specialist evolutionary ecology, for example by referencing some of the more recent literature devoted to the evolution of hostplant specialization.

That notwithstanding, this text is, overall, extremely well-referenced with roughly 450 citations, more than a third of which are published since 1993, and almost two thirds since 1980. Quotations provided from such early American entomologists as T. W. Harris are of historical as well as biological interest (Harris's bizarre quote on p. 234 comparing the extermination of larvae to that of Florida Indians notwithstanding). I was delighted to read that my father's habit of torching *Malacosoma* tents with kerosene-soaked rags was a not-unusual, but uniquely American tradition (pp. 236–237). Both historically and scientifically, Fitzgerald's account of applied entomological research as regarding tent caterpillars is thorough—down to the mechanistic descriptions of biological control agents—and makes for fascinating reading.

Although I found the presentation of evolutionary life history scenarios somewhat deficient, I recommend this data-rich book for its breadth of coverage and as an intriguing synthesis of the biology of a fascinating and oft-overlooked group of organisms. Fitzgerald has clearly inspired a generation of tent caterpillar researchers and afficionados, and both his skills and those of his former students in field- and laboratory-based experimental design are evident from the impressive contribution of data summarized in this text. The final chapter will no doubt prompt numerous classroom studies, and may well add to Fitzgerald's apparent legacy of enthusiastic protogés.—*Paul Z. Goldstein, Dept. of Entomology, American Museum of Natural History, Central Park West at 79th St., New York, New York 10024.*

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CONTRIBUTIONS IN HONOR OF LAWRENCE HUBERT ROLSTON

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His career in entomology had a modest beginning, and it ended without fanfare when he retired on 1 October 1994. Yet, the forty-two years between beginning and end are filled with scientific achievements. Taxonomist, applied entomologist, researcher, educator—he is an uncommon man who has enjoyed an uncommon career.

Beautiful West Virginia is the perfect habitat for a naturalist. Appropriately, it was in the small city of Parkersburg, on April 14, 1922, that a future student of the life sciences was born to Forrest and Edna Richardson Rolston. The oldest of five children, his given names are Lawrence Hubert, but his friends and colleagues know him as L. H. or "Larry" Rolston.

His love of nature began with his earliest memories of growing up surrounded by a countryside that offered a fascinating variety of flora and fauna, precipitous hills to climb, and sparkling streams for fishing and swimming. With fondness, Rolston recalls the years he spent on the hill farm of his grandparents, and he is quick to note that the harsh winters and hard work were more than offset by the warm intimacy of close-knit family farm life. He considers his rural upbringing one of his greatest blessings.

After receiving his early education in the public school system in Wood County, West Virginia, Rolston moved to Virginia to seek employment. He worked as an apprentice toolmaker in the Newport News Shipbuilding and Drydock Company. This proved to be a dull and uninspiring job for a young man who had never before been confined to an urbanized, industrial environment. He was dutifully performing his toolmaker tasks when Pearl Harbor was bombed, and he waited only a few months before enlisting in the Air Force. He served from September, 1942, until December, 1945. His military career took him to the European theater of war, primarily England, France, and Germany.

As a World War II veteran, Rolston enrolled in Marietta College in Ohio with the intention of studying mechanical engineering. Although he is the type to persevere, he soon found engineering classes as boring as toolmaking, and he was not enthusiastic about spending his life in a profession he did not enjoy.

A major turning point occurred when he chose a zoology course to fulfill part of the science requirement of Marietta College. Not only did he find the class fascinating, but it was taught by a man who had a profound influence on the young veteran. Professor Harla Ray Eggleston was an excellent and dedicated teacher, and a man to be emulated. The Harvard graduate convinced Rolston that his future was in some aspect of zoology.

As an undergraduate, Rolston worked for several summers at the Washington County Experiment Truck Farm for C. R. Neiswander, Chairman of the Department

of Entomology at the Ohio Agricultural Experiment Station. While there, he became intrigued with insects, and he credits Neiswander with enlightening him to the fact that one could actually make a living in entomology. His future finally began to focus.

At Marietta College, he distinguished himself by being inducted into Beta Beta Beta and Phi Beta Kappa, and by graduating cum laude with a BA degree in 1949. He began graduate work at Ohio State University where he received a master's degree in 1950 and a doctorate in 1955. While there he was selected for membership in Gamma Sigma Delta and Sigma Xi.

A seemingly ordinary career began in 1952 when he was hired by the University of Arkansas as an applied entomologist. Surprisingly, one of his first assignments was to resurrect the entomological museum which consisted of a few specimen cabinets and many Schmidt boxes which had been stuffed into a storage room. This discouraging task proved to be remarkably significant for Rolston since it marked the beginning of what would become a long and distinguished taxonomic career.

While immersed in organizing and re-establishing the museum, he pioneered research on the southwestern corn borer which was severely damaging crops in Arkansas. Rolston's research determined that by planting corn early, farmers could avoid much of the damage done by the second generation of corn borer larvae. This was of tremendous benefit to the farmers. His corn borer research also provided data for his thesis and dissertation topics.

Although Arkansas farmers were extremely pleased, Larry Rolston, as usual, was unassuming about the importance of his research. A short incident involving his father may be an indication that his lack of egotism is a genetic trait. Rolston remembers taking his dad on a tour of test plots to view his work on the corn borer. After seeing the little pest and hearing the basics of the ongoing research, the pragmatic and candid Forrest Rolston commented: "Well, if somebody wants to pay you for doing this, I suppose it's all right." This remark was inoffensive since it had long been understood between the two that the elder Rolston did not give compliments easily, and the younger Rolston did not expect any.

In 1955, he moved back to the Ohio Agricultural Experiment Station to again work for C. R. Neiswander. His assignment there was also on corn insects.

Offered a position at the University of Arkansas which was professionally more interesting and rewarding, Larry Rolston moved back to Fayetteville in 1957. The next nine years proved to be busy and stimulating. Once again he found himself wearing two hats: he curated the museum, and he also worked on vegetables, rice and stored grain. In particular, he did research on Grape Colaspis, an insect that was crippling rice production. His intensive research on the problem revealed that damage could be reduced or avoided if the rice seeds, not the rice plants, were treated with insecticides. This was an economic blessing for the rice industry, and a gratifying research accomplishment for Rolston.

Although he liked the Fayetteville area, ranking it second only to Parkersburg in natural beauty, he felt it was time to look for new professional horizons. He left the University of Arkansas in 1966 to accept a position with Texas A&M University for an assignment in the Dominican Republic on an AID project.

His general objectives and assigned duties were to guide the development of a functional department of plant protection. Specifically, he was to initiate or improve

extension, research, and regulatory activities essential to plant protection on a national scale, and also to eliminate unrelated activities. When he arrived in Santo Domingo, he found a politically corrupt Dominican Republic government which had staffed the department with inefficient and generally incompetent workers who were untrained, disinterested, and using antiquated equipment. Despite his best efforts, many of the problems were insurmountable, and Rolston was never able to satisfactorily accomplish his goals.

A bright spot in this tour of duty, however, involved his taxonomic work. Seeing a need for systematic services within the divisions of entomology and phytopathology, Rolston wrote a proposal for a national diagnostic center. Grants were secured, partially on the basis of this proposal, and the foundation for an outstanding insect collection in the West Indies was begun. J. C. Schaffner of Texas A&M University is credited with being a key figure in this endeavor since he channeled specimens to appropriate specialists for identification, and returned the named specimens to the San Cristobal Center. His generous efforts also helped to sharply focus Rolston's interest in taxonomic work. Several thousand specimens were collected for this project—mostly by Larry Rolston, but many by Schaffner. Rolston notes that his service in the Dominican Republic was an interesting entomological experience, and it also provided an opportunity to assess the effectiveness of the AID program. His end of tour report did not gladden the hearts of the AID administrators in Washington, D.C.

In addition to the Dominican Republic, his career has taken him to many parts of the world: the Philippines, Japan, Nigeria, Sierra Leone, Surinam, Panama, Guatemala, Nicaragua, Mexico and Venezuela.

Rolston observes that a side benefit from his tour of duty in the Dominican Republic was that it prepared him for living and working in Louisiana. An offer from L. D. Newsom, Head of the Department of Entomology at Louisiana State University, brought him to Baton Rouge in 1968. Newsom appointed Rolston to the position as a full professor.

At LSU, he began his applied assignment on vegetable insects. This continued until the sweet potato entomologist, unfortunately, died. This left a vacancy which Rolston was appointed to fill while continuing to work on vegetables. He particularly enjoyed working with the sweet potato growers, but found that the industry was in trouble and was having difficulty competing with North Carolina growers. In 1978 he began attempts to breed a new variety, even though plant breeding was not his field. His new variety was released in 1987 by the Louisiana Agricultural Experiment Station. Being a history buff, Rolston named his new sweet potato "Beauregard," after the confederate general he so admires. The new potato was exceptionally successful. Mike Cannon, horticulturist with the Louisiana Cooperative Extension Service, and a team contributor to Beauregard's development, predicted it had the potential to "revolutionize the sweet potato industry." He was correct—Beauregard now accounts for approximately 90 percent of the crop in Louisiana as well as in Texas, Mississippi and Alabama. It is also grown in other sweet potato producing areas and has received international recognition for future production.

In addition to Cannon, Rolston recognizes Chris Clark, LSU plant pathologist, as contributing to the team effort in the development of Beauregard. He credits Teme Hernandez, professor of horticulture (now retired), for his invaluable assistance and collaboration.

Beauregard gave the sweet potato industry the boost it needed, and it brought prosperity to farmers who were struggling to keep the crop alive economically. To express their appreciation, they chose Larry Rolston to be Mr. Yam of the 43rd Yambilee Festival held in Opelousas, Louisiana in October, 1988. This is an honor bestowed on someone each year who has made a substantial advance in the progress and growth of the sweet potato industry. While this role was slightly out of character for one who usually shuns the spotlight, Rolston was deeply appreciative of the honor extended him by the farmers he holds in such high esteem.

Still enjoying the satisfaction of his meaningful contribution to the sweet potato industry, tragedy struck. In 1989, Rolston suffered a nearly fatal heart attack. Although he seemingly recovered and resumed his career, he suffered a second major coronary attack two years later and had to undergo triple bypass surgery. Even this did not stop the indomitable Rolston for long. Most people rest while suffering and recuperating; he worked on taxonomy at home while suffering and recuperating. His inherently willful nature helped him make the best of a bad situation.

While Rolston was making significant contributions in applied entomology, he was also progressing as a taxonomist. His taxonomic field is pentatomids (stinkbugs), and he has an international reputation for being one of the world's foremost experts on this family of bugs. He identifies specimens for many of the world's largest museums, and during his taxonomic career he has described more than a hundred new species which will bear his name forever as author of their scientific names. The importance of this realm of his work cannot be over-emphasized since many of the new species which he identifies from the neotropics could become extinct as habitats are destroyed. It is understandable that Rolston's colleagues jokingly refer to him as the "Godfather of Stinkbug Taxonomy."

A prolific publisher, Rolston is one of those rare scholars who has the ability to write well and lucidly to make the point intended. He has an impressive list of publications in his fields of applied research and taxonomy, and he is currently working with David Rider on a catalog of the pentatomids of the world.

Among his greatest professional pleasures are his interactions with the bright young scientists who are already helping to carry the torch he will relinquish upon his retirement. Those with whom he has enjoyed working and hopes he has helped or influenced to some degree are: Joseph Eger, entomologist with DowElanco, Tampa, Florida; David Rider, faculty member, Department of Entomology, North Dakota State University; E. G. Riley, Collection Manager, Entomology Museum, Texas A&M University; and Donald Thomas, with the USDA Subtropical Research Laboratory, Weslaco, Texas.

It seems appropriate at this point to consider Larry Rolston as a man. What sort of character is he? "Unique" is probably the best one-word description.

Those who know him well will agree that he is a paradox in many ways. His quiet, unobtrusive personality belies his intense reaction when occasion demands it. Although he appears to be reserved and passive, he will unhesitatingly speak out on important issues while others remain safely in the shadows. Honest and straightforward to the point of being blunt, he has been known to "rock a few boats" and "ruffle a few feathers." He will jump to the defense of whomever he believes is right—friend or foe, colleague or stranger—without fear of personal repercussions. Some would call him dogmatic and opinionated; others would describe him as de-

cisive and outspoken. Dignified and resolute, he has a natural demeanor which usually commands respect, but often intimidates the fainthearted.

This may make him seem formidable, but he is not. One can easily see that behind the austere facade there is a kind, generous, gentle man. His strength of character can be seen in his exceptional composure, and his air of calmness and imperturbability gives those in his presence a sense of peace and order.

An avid sports fan, voracious reader, connoisseur of food, and "borderline" gourmet chef, his interests, in general, are too numerous to mention. But he never tires of the wonders of nature and the beauty of the world. He is, indeed, unique, paradoxical, impressive and interesting in many ways.

His four children from his first marriage are successful in their own right: Col. David Rolston, U.S. Army, stationed at Fort Monroe, Virginia; Gordon Rolston, Senior Test Officer who works in the NASA space program in Houston; Carla (Rolston) Hebert, graduate of LSU and employed with the Louisiana Animal Breeder's Cooperative in Baton Rouge; and Clyde Rolston who holds degrees from LSU and Temple University, Philadelphia, and is an assistant professor of marketing at Belmont University, Nashville.

Rolston's record of career accomplishments speaks for itself—it would have to. He is much too unimpressed by his achievements to think that he deserves special credit or recognition. Yet, it is evident from the dedication of this volume in his honor that his colleagues consider his contributions to entomology as significant. There is no doubt that he will be deeply moved by this wonderful tribute.

After retiring, he will continue to live in Baton Rouge with his wife, Joyce Nelson Rolston, who bravely assumes full responsibility for his character analysis, and who compares his choice of career to Robert Frost's poem, "The Road Not Taken":

. . . Two roads diverged in a wood, and I—
I took the one less traveled by,
And that has made all the difference.

Larry Rolston—an uncommon man who chose an uncommon road and enjoyed an uncommon career.

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NAMES PROPOSED AND TAXONOMIC PUBLICATIONS BY LAWRENCE H. ROLSTON

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Abstract.—A list of names proposed and a bibliography are presented for Lawrence H. Rolston.

Lawrence H. Rolston has led a long and distinguished career, not only as a taxonomist, but also as an applied entomologist. The pages that follow contain a list of the taxonomic names (in bold) proposed by Rolston, and also a complete list of his publications. It is with great honor that we dedicate this paper to him and the impact he has had on us and pentatomid systematics.

The senior author (DAR) now has all of Rolston's remaining reprints. Future reprint requests can be sent to DAR (note that there are no longer any reprints available for some of Rolston's papers).

LIST OF NAMES PROPOSED AND THEIR CURRENT STATUS IF CHANGED

ACANTHOSOMATIDAE

Mazanoma Rolston and Kumar, 1975:272, 273.
M. **variada** Rolston and Kumar, 1975:273–275, figs. 1–7.
Tolono Rolston and Kumar, 1975:272, 275–276.
M. **decoratus** Rolston and Kumar, 1975:276–278, figs. 8–15.

PENTATOMIDAE: DISCOCEPHALINAE

A. Tribe Discocephalini

Ablaptus **brevirostrum** Rolston, 1988a:285, 286–288, figs. 3–7.
A. **tavakiliani** Rolston, 1988a:285, 288–289, figs. 8–11.
Antiteuchus **englemani** Rolston, 1993:109, 118–121, figs. 41–44.
A. **rideri** Rolston, 1993:109, 122–126, figs. 66–71.
A. **ruckesi** Rolston, 1991:235–238, figs. 1–6.
A. **rufitarsus** Rolston, 1993:109, 113–115, figs. 19–22.
Parvamima **mexicana** Rolston, 1987c:73–75, figs. 2, 10–14.
Priapismus **costaricensis** Rolston, 1984a:120, 125, figs. 15–17.
P. **ecuadorensis** Rolston, 1984a:120, 124–125, figs. 12, 13.

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[1] Also, Research Associate, Florida State Collection of Arthropods, Florida Department of Agriculture and Consumer Services, Gainesville, FL 32602.

P. **pini** Rolston, 1992c:488–490, figs. 1–9.

B. Tribe **Ochlerini** Rolston, 1981:40–41.

Alathetus **haitiensis** Rolston, 1982a:156–158, figs. 1, 3.
Barola Rolston, 1992a:4, 16–17.
B. **farfala** Rolston, 1992a:17, figs. 25–28.
Catulona Rolston, 1992a:5, 30.
C. **apaga** Rolston, 1992a:32–33, figs. 73–78.
C. **pensa** Rolston, 1992a:31–32, figs. 67–72.
Clypona Rolston, 1992a:4, 17–19.
C. **aerata** Rolston, 1992a:19, figs. 29, 30.
Coranda Rolston, 1992a:6, 36–37.
C. **castana** Rolston, 1992a:37–38, figs. 86–88.
Cromata Rolston, 1992a:6, 33–34.
C. **ornata** Rolston, 1992a:34, figs. 79, 80.
Forstona Rolston, 1992a:4, 20.
F. **speciosa** Rolston, 1992a:20–21, figs. 32–34.
Lincus **anulatus** Rolston, 1983a:5, 22–24, figs. 45–48.
L. **breddini** Rolston, 1983a:6, 33–35, figs. 71–74.
L. **convexus** Rolston, 1983a:5, 16–17, figs. 22–24.
L. **croupius** Rolston, 1983a:5, 12–13, figs. 12–15.
L. **fatigus** Rolston, 1983a:5, 10–11, figs. 10, 11.
L. **hebes** Rolston, 1989:271–273, figs. 1–5.
L. **incisus** Rolston, 1983a:4, 9–10, figs. 8, 9.
L. **laminatus** Rolston, 1983a:6, 41–43, figs. 100–103.
L. **leviventris** Rolston, 1983a:5, 30–31, figs. 64, 65.
L. **malevolus** Rolston, 1989:275–276, figs. 12–14, 17.
L. **manchus** Rolston, 1983a:5, 31–32, figs. 66–68.
L. **modicus** Rolston, 1983a:5, 28–30, figs. 60–63.
L. **operosus** Rolston, 1983a:5, 14–16, figs. 19–21.
L. **repizcus** Rolston, 1983a:5, 24–26, figs. 49–52.
L. **singularis** Rolston, 1983a:5, 18–20, figs. 34, 35.
L. **sinuosus** Rolston, 1983a:5, 13–14, figs. 16–18.
L. **spurcus** Rolston, 1989:273–275, figs. 9–11, 15, 16.
L. **substyliger** Rolston, 1983a:6, 43–46, figs. 104–107.
L. **tumidifrons** Rolston, 1983a:5, 20–22, figs. 36–44.
L. **vallis** Rolston, 1983a:6, 38–39, figs. 87–89.
L. **vandoesburgi** Rolston, 1983a:4, 7–9, figs. 1–7.
L. **varius** Rolston, 1983a:5, 26–28, figs. 57–59.
Paralincus **silvae** Rolston, 1983c:184, 185–187, figs. 2–5.
Pseudadoxoplatys Rolston, 1992a:3, 7.
P. **mendacis** Rolston, 1992a:8, figs. 1–5.
Schaefferella **fusca** Rolston, 1992a:21–23, figs. 38–42.
Stalius Rolston, 1992a:4, 11, 13.
S. **trisinuatus** Rolston, 1992a:13, figs. 14–20.
Uvaldus Rolston, 1992a:4, 25.

U. **concolor** Rolston, 1992a:26–27, figs. 50–59.

PENTATOMIDAE: PENTATOMINAE

Acrosternum (*Chinavia*) **aseadum** Rolston, 1983b:106, 132–133, figs. 82–86.
A. (*C.*) **australe** Rolston, 1983b:107, 150–152, figs. 148–152.
A. (*C.*) **bellum** Rolston, 1983b:105, 110–111, figs. 12–16.
A. (*C.*) **brasicola** Rolston, 1983b:107, 157–158, figs. 171–176.
A. (*C.*) **callosum** Rolston, 1983b:105, 113–114, figs. 23–25.
A. (*C.*) **collis** Rolston, 1983b:107, 108, 148, figs. 138–142.
A. (*C.*) **dubium** Rider & Rolston, 1986:416, 418–420, figs. 8–16.
A. (*C.*) **ecuadorensis** Rolston, 1983b:106, 134–135, figs. 90–92.
A. (*C.*) **esmeraldum** Rolston, 1983b:106, 120–121, figs. 43–48.
A. (*C.*) **euri** Rolston, 1983b:107, 140, figs. 111–119.
A. (*C.*) **froeschneri** Rolston, 1983b:105, 117–120, figs. 41, 42.
A. (*C.*) **insulani** Rolston, 1983b:105, 111–112, figs. 17–20.
A. (*C.*) **istum** Rolston, 1983b:106, 121–123, fig. 49.
A. (*C.*) **macdonaldi** Rolston, 1983b:107, 142, figs. 120–123.
A. (*C.*) **monticola** Rolston, 1983b:107, 144–145, figs. 128–130.
A. (*C.*) **occasi** Rolston, 1983b:107, 145–147, fig. 131.
A. (*C.*) **occultum** Rolston, 1983b:105, 115–116, figs. 26, 27.
A. (*C.*) **pecosum** Rolston, 1983b:106, 132, figs. 80, 81.
A. (*C.*) **pengue** Rolston, 1983b:108, 170–172, figs. 224–232.
A. (*C.*) **plaumanni** Rolston, 1983b:108, 163–165, figs. 201, 202.
A. (*C.*) **simplicis** Rolston, 1983b:107, 138–140, figs. 106–110.
A. (*C.*) **solitum** Rider & Rolston, 1986:416, 417, 420–423, figs. 17–25.
A. (*C.*) **teretis** Rolston, 1983b:107, 158–160, figs. 177–180.
A. (*C.*) **triangulum** Rider and Rolston, 1986:416, 417–418, figs. 1–7.
A. (*C.*) **ubicum** Rolston, 1983b:107, 135–137, figs. 93–99.
A. (*C.*) **wygodzinskyi** Rolston, 1983b:107, 142–144, figs. 124–127.
Agroecus **reticulatus** Rider and Rolston, 1987:429, 430–432, figs. 1, 5, 20, 26.
Caonabo Rolston, 1974a:57.
C. **casicus** Rolston, 1974a:57–59, figs. 1–12.
Capivaccius **bambusii** Brailovsky and Rolston, 1986:35–39, figs. 4, 7–10.
Caribo Rolston, 1984 (in Rolston and McDonald, 1984):74, 80–81.
C. **fasciatus** Rolston, 1984 (in Rolston and McDonald, 1984):82–83, fig. 54.
C. **subgibbus** Rolston, 1984 (in Rolston and McDonald, 1984):81–82, figs. 49–53.
Cyptocephala **alvarengai** Rolston, 1986:425, 427–429, figs. 1, 8, 15, 18–20.
C. **pallida** Rolston, 1986:425, 431–432, figs. 4, 11, 17.
Disderia **parda** Rolston, 1983d:248–251, figs. 14–19.
Elanela Rolston, 1980 (in Rolston, McDonald, and Thomas, 1980):122, 123–125.
E. **hevera** Rolston, 1980 (in Rolston, McDonald, and Thomas, 1980):125–126, figs. 8, 12, 13.
Euschistus (*Euschistus*) **achatadus** Rolston, 1974b:11, 14–17, figs. 1–9.
E. (*E.*) **agudus** Rolston, 1974b:11, 13, 19–21, figs. 18–26.

E. (*E.*) **carbonerus** Rolston, 1985c:356, 361–363, figs. 38–44. [note; sp. carboneurs on p. 361]
E. (*E.*) **chiapus** Rolston, 1974b:11, 30–31, figs. 58–66.
E. (*E.*) **corcovacitus** Rolston, 1971:486, 490, figs. 1–10.
E. (*E.*) *crenator* **orbiculator** Rolston, 1974b:14, 41, figs. 94–102.
E. (*E.*) **egglestoni** Rolston, 1974b:13, 76–77, figs. 223–231.
E. (*E.*) **emoorei** Rolston, 1972a:183–185, figs. 1–8.
E. (*E.*) **incus** Rolston, 1985c:355, 358–359, figs. 25–30. [= *Euschistus* (*E.*) *rubiginosus* Dallas, 1851 (Rider, 1986:397–398)]
E. (*E.*) **leonensis** Rolston, 1974b:13, 77–79, figs. 232–240.
E. (*E.*) **nicaraguensis** Rolston, 1972a:185–187, figs. 9–17.
E. (*E.*) **olacitus** Rolston, 1971:486–487, 490, figs. 11–16.
E. (*E.*) **palacitus** Rolston, 1971:487, 490, figs. 17–22.
E. (*E.*) **quadrator** Rolston, 1974b:14, 41–44, figs. 103–111.
E. (*E.*) **rohus** Rolston, 1985c:356, 360–361, figs. 31–37.
E. (*E.*) **ruckesi** Rolston, 1974b:11, 57–59, figs. 162–169.
E. (*E.*) **schaffneri** Rolston, 1974b:10, 65–66, figs. 188–196.
E. (*E.*) **stali** Rolston, 1974b:12, 73, 75, figs. 214–222.
E. (*E.*) **subinteger** Rolston, 1974b:11, 83–84, figs. 251–258.
E. (*E.*) **sulcacitus** Rolston, 1971:488–489, 490, figs. 23–28.
E. (*E.*) **vetus** Rolston, 1974b:12, 93–94, 96, figs. 295–301.
E. (*E.*) **zafadus** Rolston, 1974b:11, 96–97, figs. 302–311.
E. (*E.*) **zagus** Rolston, 1974b:10, 97–99, figs. 312–313.
E. (*Lycipta*) **machadus** Rolston, 1982b:283, 284–288, figs. 7–15.
E. (**Mitripus**) Rolston, 1978b:102–103.
E. (*Mitripus*) **grandis** Rolston, 1978b:103, 110–112, figs. 18–24.
Grazia Rolston, 1981 (in Rolston and McDonald, 1981):260, 262–263.
Kermana Rolston, 1981 (in Rolston and McDonald, 1981):260, 265.
Ladeaschistus Rolston, 1973b:101, 103–105.
L. **boliviensis** Rolston, 1973b:107, 110, figs. 19–23.
Lojus **bordoni** Brailovsky and Rolston, 1986:31–35, figs. 1–3.
Mathiolus **labiatus** Rolston, 1988b:292, 294–296, figs. 10–15.
M. **tumidus** Rolston, 1988b:292, 296–297, figs. 16–20.
Menecles **portacrus** Rolston, 1973a:235–236, figs. 1, 7–11.
Mormidea **dana** Rolston, 1978c:170, 171, 197–198, figs. 54–55.
M. **faisana** Rolston, 1978c:168, 171, 172, 198–199, figs. 56–57.
M. **guatemalensis** Rider and Rolston, 1989:106, 108–110, figs. 21–25.
M. **isla** Rolston, 1978c:168–169, 207, fig. 76.
M. **kirkaldyi** Rolston, 1985a:342.
M. **lunara** Rolston, 1978c:168, 211, 213, fig. 82.
M. **pama** Rolston, 1978c:171, 205–207, figs. 68–70.
M. **polita** Rider and Rolston, 1989:106–108, figs. 14–20.
M. **rugosa** Rolston, 1978c:170, 193–194, figs. 52–53.
M. **vaya** Rolston, 1978c:167, 184–185, figs. 31–34.
Moromorpha Rolston, 1978c:163–164.
Nocheta Rolston, 1980 (in Rolston, McDonald, and Thomas, 1980):123, 129.

N. **adda** Rolston, 1980 (in Rolston, McDonald, and Thomas, 1980):129–130, fig. 20.

Odmalea **norda** Rolston, 1978a:23, 30–32, figs. 36–44.

O. **vega** Rolston, 1978a:23, 34–35, figs. 56–58.

Patanius Rolston, 1987a:62, 63–64.

P. **vittatus** Rolston, 1987a:64–66, figs. 7–12.

Pellaea **santarosensis** Rolston, 1985b:344–347, figs. 1–16.

Roferta Rolston, 1981 (in Rolston and McDonald, 1981):260, 266–267.

Senectius Rolston, 1987a:62, 66.

S. **metallicus** Rolston, 1987a:66–68, figs. 13–16.

Serdia (*S.*) **beckeri** Thomas and Rolston, 1985:1166, 1171–1172, figs. 1, 2, 9.

S. (*S.*) **bihamulata** Thomas and Rolston, 1985:1166, 1172, fig. 3.

S. (*S.*) **delphis** Thomas and Rolston, 1985:1166, 1168–1171, figs. 4, 8.

S. (*S.*) **lobata** Thomas and Rolston, 1985:1166–1167, fig. 5.

S. (*S.*) **quadridens** Thomas and Rolston, 1985:1166, 1168, fig. 6.

S. (*S.*) **ruckesi** Thomas and Rolston, 1985:1166, 1167–1168, fig. 7.

Sibaria **englemani** Rolston, 1975:220, 222–223, figs. 1–11.

Spinalanx Rolston and Rider, 1988:299, 300.

S. **corusca** Rolston and Rider, 1988:302–303, figs. 12–14.

S. **monstrablis** Rolston and Rider, 1988:300–302, figs. 3–11.

Stictochilus **barbatus** Rolston and Rider, 1986:79–81, figs. 2, 5, 8.

S. **bituberculatus** Rolston and Rider, 1986:79, 81–82, figs. 1, 4, 7.

Tepa Rolston and McDonald, 1984:71, 74, 76–80.

Thyanta **yerma** Rolston, 1972b:278–281, 283–284, figs. 1–11. [= *Tepa yerma* (Rolston and McDonald, 1984:78)]

Vidada Rolston, 1980 (in Rolston, McDonald, and Thomas, 1980):122, 130.

V. **dollingi** Rolston, 1980 (in Rolston, McDonald, and Thomas, 1980):130–131, figs. 21, 22.

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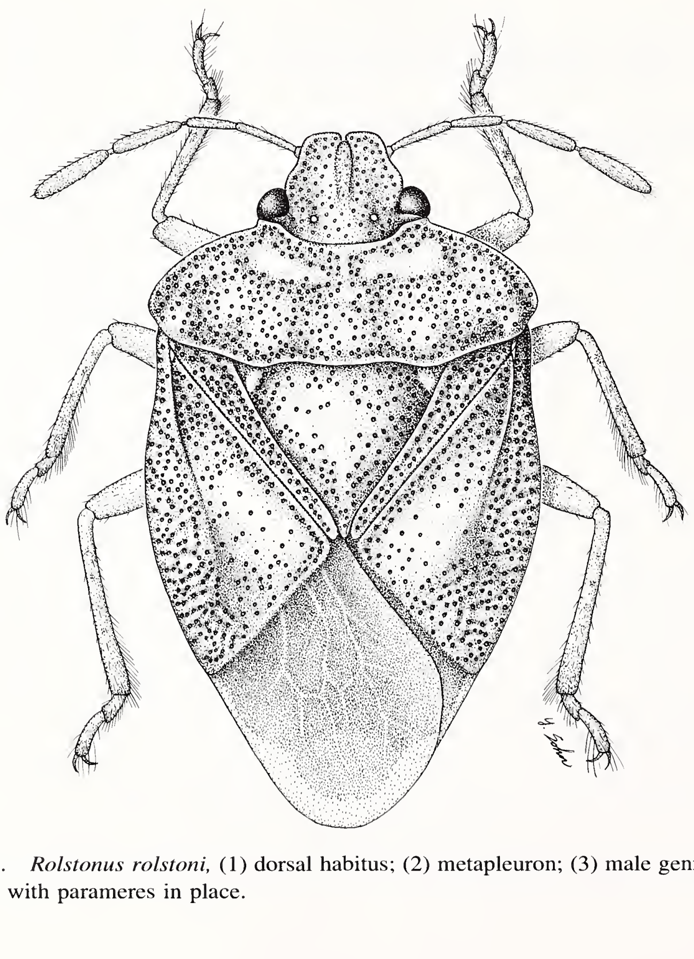
J. New York Entomol. Soc. 103(4):360–363, 1995

ROLSTONUS ROLSTONI, NEW GENUS AND NEW SPECIES OF ACANTHOSOMATIDAE FROM ARGENTINA (HETEROPTERA: PENTATOMOIDEA: DITOMOTARSINI)

Richard C. Froeschner

Abstract.—*Rolstonus rolstoni,* a new genus and species from Argentina, is described and illustrated.

Among the specimens of the family Acanthosomatidae in the National Museum of Natural History, Washington, D.C., is an unusual one measuring just 5.1 mm in length and representing a new genus and new species. It is my pleasure to name this



Figs. 1–3. *Rolstonus rolstoni,* (1) dorsal habitus; (2) metapleuron; (3) male genital capsule, dorsal view with parameres in place.

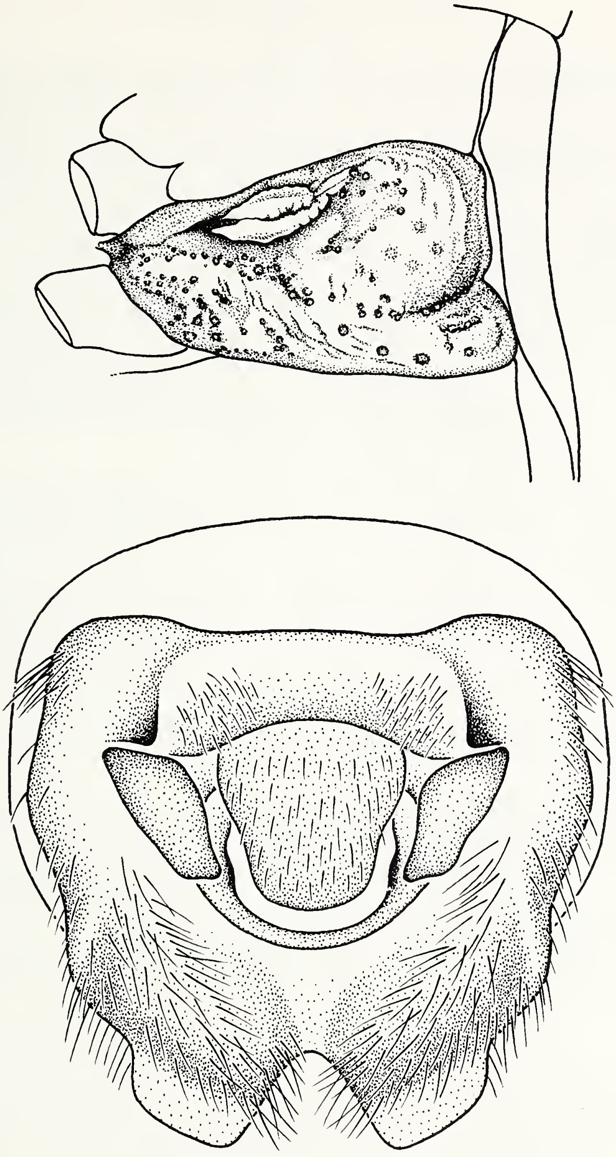


Fig. 1–3. Continued.

new genus and new species *Rolstonus rolstoni* as a tribute to our friend and colleague, Dr. L. H. Rolston, who over many years, has published much from which we gained a more detailed understanding of the hemipterous superfamily Pentatomoidea in the New World. As yet, the host of this insect is unrecorded.

Rolstonus, new genus

Diagnosis: Ditomotarsinae: Ditomotarsini: *Rolstonus* is the only genus of the tribe Ditomotarsini with the combination of the juga distinctly surpassing and incurved (not quite in contact) beyond the tip of the clypeus (Fig. 1), the margins of the head concealing the antennophores in dorsal view, and the prosternum weakly convex.

In Kumar's (1974:5) key to the world's genera of the tribe Ditomotarsini, *Rolstonus* runs to the African genus *Uhlunga* Distant because it has a low but distinct mediolongitudinal carina on the mesosternum, but it differs from *Uhlunga* by numerous characters, the most conspicuous being the antennophores are concealed from dorsal view by the expanded margins of the head. In the keys to South American genera of Acanthosomatidae by Rolston and Kumar (1975:271) and by Froeschner (1981:8–9), it would be identified as *Mazanoma* Rolston and Kumar because its juga distinctly surpass the clypeus, but the sole member of that genus is much larger, measuring, 8.7–9.6 mm, has a strong, mediolongitudinal groove on the prosternum, and a strongly deflexed preocular part of the head.

Characters: (Known from a single male). Outline oval, humeral angles weakly protruding laterad of costal margin. Dorsal surface, except membrane, mostly closely punctate. Costal margin of hemelytron convex on apical two-thirds, without the "hump" of Kumar (1974).

Head: Not deflexed anterior to eyes. Juga surpassing and incurved beyond apex of clypeus. Antennophores unarmed, hidden from dorsal view by expanded margins of head. Antennal segment I short, not reaching apex of head, V longest. Bucculae low, posteriorly rather abruptly terminated under eyes, a short distance from base of head. Labium reaching between posterior coxae, segment I not surpassing bucculae, subequal in length to IV, II and III equal, each somewhat longer than I or IV. Maxillary tubercle absent.

Pronotal width slightly more than two-and-a-half times median length. Anterior margin deeply concave between eyes. Anterolateral margin expanded, carinate, outline weakly convex; anterolateral angles vaguely projecting. Humeri rounded, noticeably projecting beyond costal outline. Scutellum triangular, slightly wider than long, apex acute, each basal angle with a small pale callous.

Hemelytra slightly surpassing apex of abdomen. Costal margin weakly convex on apical two-thirds. Mesocorium with apical margin straight, outer apical angles slightly rounded.

Prosternum weakly convex, without mediolongitudinal groove. Propleuron and mesopleuron mostly shining, with numerous punctures. Metapleuron with widely separated punctures. Ostiolar canal elongate, narrow, distinctly grooved longitudinally, extending slightly less than half way from ostiolar opening to lateral margin of supporting sclerite (Fig. 2); evaporative area surrounding only basal part of ostiolar canal and extending along narrow posterior margin of mesosternum. All tibiae convex dorsally, without a subbasal angulation.

Abdomen shining, finely alutaceous, virtually impunctate.

Type-species: *Rolstonus rolstoni* new species, here designated.

Etymology: This new genus is dedicated to a long time personal friend and a scholar of the New World Pentatomoidea, L. H. Rolston, and is formed by adding the Latin masculine ending *us* to his name.

Rolstonus rolstoni, new species
Figs. 1–3

Diagnosis: As the only member of the genus, this species is recognized by the generic characters.

Characters (measurements in mm): Holotype, ♂. Length 5.1; width across humeral angles, 2.9. Antennal segments, I, 0.32: II, 0.47: III, 0.32; IV, 0.50: V, 0.63. Labial segments, I, 0.35: II, 0.58: III, 0.58: IV, 0.38.

Color dull yellowish, irregularly marked with pale red; dorsally with pinkish areas, including many of the punctures, that give it a pinkish cast; abdomen ventrally with a broad, longitudinally sublateral, reddish-brown band. Male genitalia as in Fig. 3.

Holotype male: Bariloche, Rio Negro, Argentina, Nov. 1926, R&E Shannon [National Museum of Natural History, Washington, D.C.].

Etymology: The species name reinforces the dedication to Dr. L. H. Rolston.

Distribution: Known only from the holotype from Argentina.

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Rolston, L. H. and R. Kumar. 1975 (1974). Two new genera and two new species of Acanthosomatidae (Hemiptera) from South America, with a key to the genera of the Western Hemisphere. J. New York Entomol. Soc. 82:271–278.

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DESCRIPTION OF THREE NEW SPECIES OF *HEISSHYGIA* BRAILOVSKY FROM NEW GUINEA (HEMIPTERA: HETEROPTERA: COREIDAE: COLPURINI)

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Abstract.—*Heisshygia rolstoni* n. sp., *H. amplissima* n. sp., and *H. cephalota* n. sp., are described from New Guinea. A key is provided to distinguish the known species. The presence of ocelli in *Heisshygia* is shown to correct the original description.

Members of the genus *Heisshygia* Brailovsky are medium sized colpurine bugs characterized by having all femora ventrally armed, the tylus upturned to form a sharp horn, antennal segment I as well as the dorsal surface of each femur nodulose, each buccula with sharp mesial projection, and abdominal sternite VII of the female with plica and fissura. Although the biology of most species remains poorly known or completely unknown, one of the species discussed below appears to live on "Melastom" (*Medinilla* sp.) and was also collected under a log.

Brailovsky (1993) described the genus *Heisshygia,* stating that members of this genus lacked ocelli. Further study of additional specimens of *H. novoguinensis* Brailovsky however, revealed that ocelli are present. They are very small and hidden, and may require cleaning of the cephalic capsule to distinguish. This character is further confirmed in the three new species herein described.

Characters previously utilized to separate *Heisshygia* from related genera remain valid except that ocelli are present in the whole group.

The following abbreviations are used in the text: Bernice P. Bishop Museum, Honolulu, Hawaii (BPBM); Museum of Comparative Zoology, Harvard University (MCZH); Colección Entomológica del Instituto de Biología, Universidad Nacional Autónoma de México (UNAM).

All measurements are in millimeters.

Heisshygia rolstoni, new species
Figs. 2, 5, 10, 11, 14, 15, 19, 20, 23, 25, 26, 28

Description. Male. *Dorsal coloration.* Dull orange brown; apex of scutellum and posterior angles of connexival segments II to VII pale yellow; head somewhat redder; antennal segments I to III pale orange hazel, IV orange hazel with basal and apical third darker; hemelytral membrane dark amber; abdominal segments bright orange red with few pale yellow or black spots. *Ventral coloration.* Bright orange hazel with yellow marks; head dull red brown with orange marks; rostral segments I to IV pale yellow; anterior lobe of each metathoracic peritreme creamy-yellow, posterior lobe orange hazel; legs light orange hazel. *Structures.* Head longer than wide; tylus surpassing juga, upturned to form sharp long horn; antenniferous tubercles unarmed; ocelli slightly tuberculate; bucculae rounded, each with sharp mesial pro-

jection; rostrum reaching medial third of abdominal sternite V. *Thorax. Pronotum.* Wider than long; collar wide; each anterior angle produced forward as small rounded lobe; anterior half of anterolateral margin obliquely sinuate, posterior half convex; humeral angles rounded, slightly exposed, distinctly elevated above disc; posterior margin straight; calli flat; pronotal disc with four projections arranged in transverse line (Fig. 2). *Legs.* Femora armed with two rows of spines along ventral surface; dorsally nodulose. *Scutellum.* Wider than long, apex subacute. *Hemelytra.* Macropterous, reaching posterior margin of last abdominal segment. *Genitalia. Genital capsule.* Posterolateral angles broadly produced, with short bifurcate medial projection (Figs. 5, 10, 11). *Parameres.* Figs. 14, 15.

Measurements. Length of head: 1.84; width across eyes: 1.60; interocular space: 0.92; interocellar space: 0.40; preocular distance: 1.18; length of antennal segments: I, 1.28; II, 1.84; III, 1.36; IV, 1.36. Pronotal length: 1.92; width across frontal angles: 1.44; width across humeral angles: 3.64. Scutellar length: 1.40; width: 1.56. Total body length: 10.20.

Female. *Color.* Similar to male. *Structures. Genital segments.* Abdominal sternite VII with plica and fissura; plica triangular, reaching medial third of sternite VII; gonocoxae I enlarged dorso-ventrally, in posterior view contiguous, in lateral view with upper margin broad, slightly convex, and lower margin subglobose apically; each paratergite VIII short, triangular, with spiracle visible; each paratergite IX nearly square, larger than VIII (Figs. 19, 20, 23). *Spermatheca.* Bulb elongate, duct relatively coiled, chambers globose (Fig. 25).

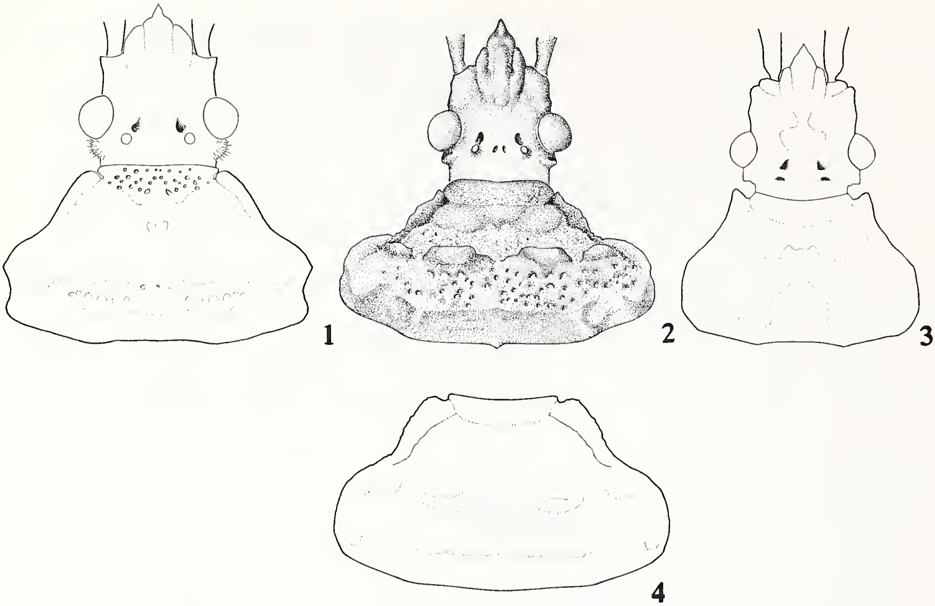
Measurements. Length of head: 1.94; width across eyes: 1.70: interocular space: 1.04; interocellar space: 0.47; preocular distance: 1.22; length of antennal segments: I, 1.40; II, 2.00; III, 1.48; IV, 1.28. Pronotal length: 1.96; width across frontal angles: 1.48; width across humeral angles: 3.76. Scutellar length: 1.48; width: 1.60. Total body length: 10.90.

Habitat. Collected on "Melastom" (*Medinilla* sp.) and under log.

Holotype male. PAPUA NEW GUINEA: NE: Edie Ck., near Wau (2050 mts.), 31.III.66. J. L. Gressitt. Deposited in BPBM.

Paratypes. Five males, five females labeled: PAPUA NEW GUINEA: NE: Edie Ck., near Wau (2,050–2,300 mts.), VII.65, 31.III.66 and 3.XI.66. J. Sedlacek, J. L. Gressitt and C. A. Samuelson; deposited in BPBM and UNAM. Four males, four females labeled: PAPUA NEW GUINEA: Mt. Kaindi (2,350 mts.), 23.III.66, 15.IV.66, 30.V.66 and 17.VI.66. J. L. and M. Gressitt; deposited in BPBM and UNAM. One male labeled: PAPUA NEW GUINEA: NE: Wau (2,400 mts.), 9–12.I.62. J. and M. Sedlacek and G. Monteith; deposited in BPBM. One male labeled: PAPUA NEW GUINEA: NE: Bulldog Rd., 4 km. S. Edie Ck. (2,405 mts.), 4–10.VII.69. J. Sedlacek; deposited in BPBM. One male labeled: PAPUA NEW GUINEA: NE: MOROBE DISTRICT: Mt. Kaindi (2,300 mts.), 15.III.67. J. J. H. Szent Ivany; deposited in BPBM. Two males, one female without locality; deposited in BPBM.

Discussion. The only other previously known species, *H. novoguinensis,* is characterized by the armed antenniferous tubercles (Fig. 1), rounded scutellar apex, flat pronotal disc with posterior median depression and middle third slightly tuberculate, hemelytra micropterous, with clavus and corium fused, membrane narrow, and pos-



Figs. 1–4. Head and pronotum of *Heisshygia* spp. Fig. 1. *H. novoguinensis.* Fig. 2. *H. rolstoni.* Fig. 3. *H. cephalota.* Fig. 4. *H. amplissima.*

terior margin of the genital capsule with two short posterolateral projections surrounding mesial broad plate (Fig. 7).

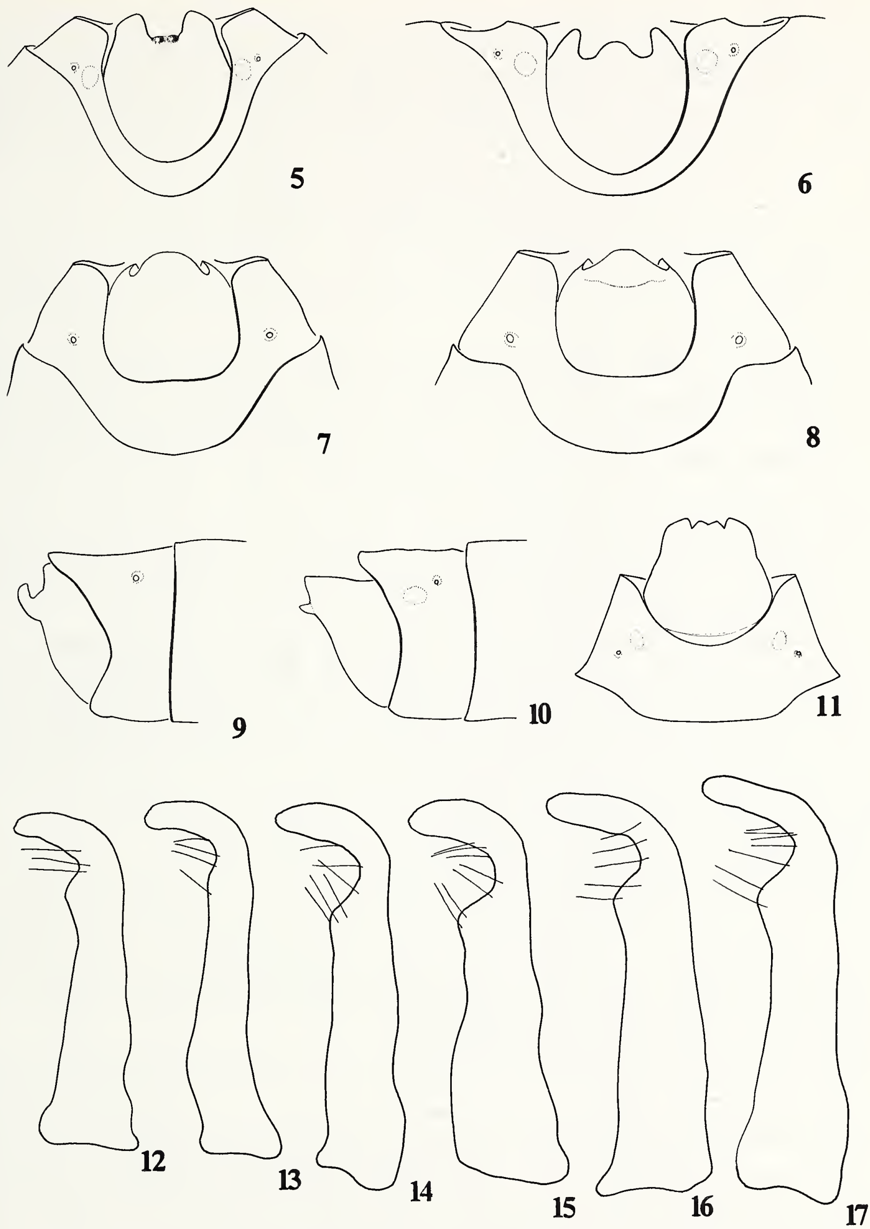
Heisshygia rolstoni, new species, has the antenniferous tubercles unarmed (Fig. 2), scutellum with subacute apex, pronotal disc with four projections arranged in transverse line (Fig. 2), hemelytra macropterous, reaching posterior margin of last abdominal segment, and posterolateral angles of the genital capsule laterally produced and between them a short bifurcate plate (Figs. 5, 10, 11).

Etymology. I am pleased to name this new species for Dr. L. H. Rolston, distinguished hemipterist, in recognition of his many fundamental contributions to the study of Neotropical pentatomids.

Distribution. Known only from the type locality in New Guinea.

Heisshygia amplissima, new species
Figs. 4, 6, 8, 9, 12, 13, 18, 21, 24, 29, 30

Description. Male. *Dorsal coloration.* Dull orange brown; apex of scutellum and posterior angles of connexival segments II to VII pale yellow; antennal segments I to III pale orange hazel, IV orange hazel with base and apex darker; hemelytral membrane dark amber; abdominal segments bright orange red with few pale yellow or black spots. *Ventral coloration.* Bright orange hazel; head dull red brown with orange marks; rostral segments I to IV pale yellow; anterior lobe of each metathoracic peritreme creamy-yellow, posterior lobe black; legs light orange hazel. *Structures.* Head longer than wide; tylus surpassing juga, upturned to form sharp long horn; antenniferous tubercles unarmed; ocelli slightly tuberculate; bucculae like *H.*



Figs. 5–17. Male genital capsule of *Heisshygia* spp. Figs. 5–7. Posterior view. Fig. 5. *H. rolstoni.* Fig. 6. *H. amplissima.* Fig. 7. *H. novoguinensis.* Fig. 8. Ventral view of *H. amplissima.* Figs. 9, 10. Lateral view. Fig. 9. *H. amplissima.* Fig. 10. *H. rolstoni.* Fig. 11. Ventral view of *H. rolstoni.* Figs. 12–17. Parameres of *Heisshygia* spp. Figs. 12, 13. *H. amplissima.* Figs. 14, 15. *H. rolstoni.* Figs. 16, 17. *H. novoguinensis.*

rolstoni; rostrum reaching abdominal sternite VI. *Thorax. Pronotum.* Wider than long; collar wide; each anterior angle produced forward as large conical tooth; anterior half of anterolateral margin obliquely sinuate, posterior half convex; humeral angles rounded, slightly exposed, distinctly elevated above disc; posterior margin straight; calli flat; pronotal disc with four projections arranged in transverse line (Fig. 4). *Legs.* Like *H. rolstoni. Scutellum.* Wider than long, apex subacute. *Hemelytra. Macropterous condition* (in both sexes). Reaching posterior margin of last abdominal segment. *Submacropterous condition* (in both sexes). Reaching posterior margin of abdominal segment VI. *Genitalia. Genital capsule.* Posterolateral angles narrowly produced and between them with a wide medial projection (Figs. 6, 8, 9). *Parameres.* Figs. 12, 13.

Measurements. Male macropter, male submacropter. Length of head: 1.72, 1.88; width across eyes: 1.58, 1.70; interocular space: 0.90, 0.96; interocellar space: 0.40, 0.42; preocular distance: 1.14, 1.21; length of antennal segments: I, 1.20, 1.40; II, 1.80, 1.86; III, 1.24, 1.34; IV, 1.24, 1.44. Pronotal length: 1.96, 2.08; width across frontal angles: 1.60, 1.62; width across humeral angles: 3.36, 3.44. Scutellar length: 1.48, 1.52; width: 1.52, 1.56. Total body length: 9.76, 10.65.

Female. *Color.* Similar to male. *Structures. Genital segments.* Abdominal sternite VII with plica and fissura; plica triangular, wider, reaching posterior third of sternite VII; gonocoxae I enlarged dorso-ventrally, in posterior view contiguous, in lateral view straight; paratergite VIII and IX similar to *H. rolstoni.*

Measurements. Female macropter, female submacropter. Length of head: 1.84, 1.94; width across eyes: 1.72, 1.80; interocular space: 1.00, 1.00; interocellar space: 0.48, 0.48; preocular distance: 1.24, 1.24; length of antennal segments: I, 1.40, 1.40; II, 2.08, 1.96; III, 1.44, 1.36; IV, 1.44, 1.32. Pronotal length: 2.24, 2.16; width across frontal angles: 1.88, 1.76; width across humeral angles: 3.92, 3.96. Scutellar length: 1.56, 1.54; width: 1.74, 1.62. Total body length: 11.40, 11.60.

Holotype male. PAPUA NEW GUINEA: NE: MOROBE PROVINCE: Mt. Por (2,300–2,500 mts.), 2–3.XII.79. J. L. Gressitt. Deposited in BPBM.

Paratypes. One female labeled: PAPUA NEW GUINEA: NE: MOROBE PROVINCE: Mt. Por (2,300–2,500 mts.), 2–3.XII.79. J. L. Gressitt; deposited in BPBM. Two males, one female labeled: PAPUA NEW GUINEA: NE: Mt. Missim (2,400 mts.), 22–30.IV.68. J. L. Gressitt, R. C. A. Rice, J. Sedlacek; deposited in BPBM and UNAM. One female labeled: PAPUA NEW GUINEA: Bulldog Rd. (2,550 mts.), 27.VII.69. J. L. Gressitt; deposited in BPBM.

Discussion. *Heisshygia amplissima,* new species is easily recognisable by the medial wide projection of the posterior margin of the male genital capsule, which is enclosed by relatively slender arm-like posterolateral angles (Figs. 6, 8, 9), and the anterior angles of the pronotum produced forward as large conical teeth (Fig. 4). In *H. rolstoni* the posterolateral angles of the male genital capsule are robust, and the posterior margin has a short bifurcate medial projection (Figs. 5, 10, 11). Also the anterior angles of pronotum are produced as small rounded lobes (Fig. 2).

In *H. amplissima,* abdominal sternite VII of the female has a wide triangular plica, extending until the posterior third of that sternite, and the gonocoxae I in lateral view is straight (Figs. 18, 21, 24). In *H. rolstoni,* the plica is shorter, narrowed, and the gonocoxae I in lateral view has the upper margin broad and slightly convex, and lower margin apically subglobose (Figs. 19, 20, 23).

The parameres of *H. amplissima, H. novoguinensis* and *H. rolstoni* differs slightly as is shown in the figures 12–17.
Etymology. The specific epithet of the species is used to refer to the broad plate of the posterior margin of the male genital capsule.
Distribution. Known only from the type locality in New Guinea.

Heisshygia cephalota, new species
Figs. 3, 22

Description. Female. *Dorsal coloration.* Dull orange brown; apex of scutellum and posterior angles of connexival segments II to VII dirty yellow; head and antennal segment I somewhat redder; antennal segments II to III pale orange hazel, IV orange hazel with basal third darker; abdominal segments IV and V with some bright orange red marks. *Ventral coloration.* Bright orange hazel; rostral segments I to IV, posterior third of acetabulae and numerous maculations on abdominal sternites III to VII pale yellow to pale orange; anterior lobe of each metathoracic peritreme creamy yellow, posterior lobe black; coxae, trochanters and femora bright orange hazel (base of femora with yellow maculations); tibiae pale orange with two yellow rings; tarsi pale orange. *Structures.* Head subquadrate, nearly as long as wide; antenniferous tubercles unarmed; ocelli hidden, difficult to distinguish; tylus and bucculae like *H. rolstoni*; rostrum reaching posterior third of abdominal sternite VI. *Thorax. Pronotum.* Wider than long; collar wide; anterior angles produced forward as large conical teeth; anterior half of anterolateral margin obliquely straight, posterior half convex; humeral angles rounded, not exposed or elevated above disc; posterior margin straight; calli flat; pronotal disc with four small projections, posteriorly concave, with deep median depression (Fig. 3). *Legs.* Like *H. rolstoni. Scutellum.* Wider than long, apex acute. *Hemelytra.* Staphylinoid, reaching posterior third of abdominal segment III, contiguous for their entire length; clavus and corium fused; membrane represented by small flap. *Genitalia. Genital segments.* Abdominal sternite VII with plica and fissura; plica reaching posterior third of sternite VII; gonocoxae I enlarged dorso-ventrally, in posterior view contiguous, in lateral view straight and apically subglobose; paratergite VIII and IX similar to *H. rolstoni.*

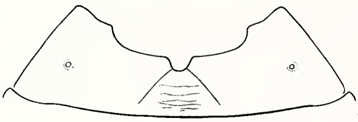
Measurements. Length of head: 1.76; width across eyes: 1.74; interocular space: 1.10; interocellar space: 0.46; preocular distance: 1.20; length of antennal segments: I, 1.40; II, 1.72; III, 1.28; IV, 1.08. Pronotal length: 1.68; width across frontal angles: 1.68; width across humeral angles: 3.00. Scutellar length: 1.04; width: 1.20. Total body length: 10.30.

Male. Unknown.

Holotype female. NEW GUINEA: Mt. Wilhelm (Bismarck Rge.) (10,000 ft), X.44. Darlington. Deposited in BPBM. No paratypes.

Discussion. This species is most closely related to *H. novoguinensis*; both have the hemelytra reduced with the clavus and corium fused, the pronotal disc posteriorly with a deep median depression, and ocelli obscure.

Heisshygia cephalota has the head subquadrate, nearly as long as wide, antenniferous tubercles unarmed, hemelytra staphylinoid, reaching posterior third of abdominal segment III and contiguous along the middle line, scutellum with apex acute, and gonocoxae I in lateral view straight (Fig. 22). In *H. novoguinensis,* the head is



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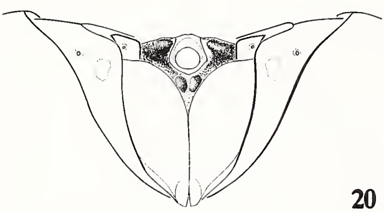

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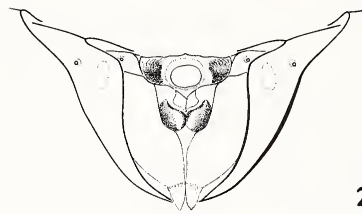

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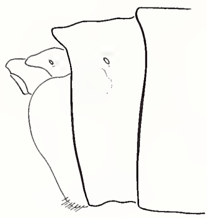

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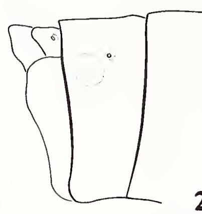

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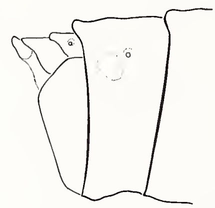

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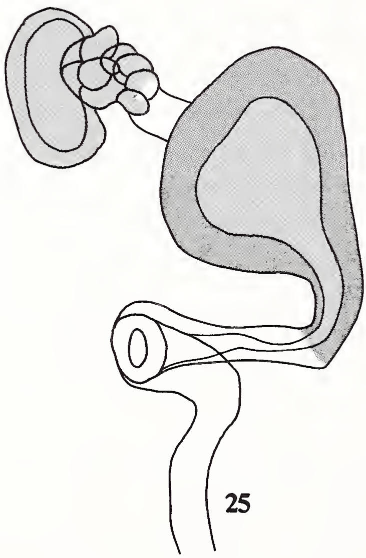

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Figs. 18, 19. Abdominal sternite VII of the female showing the plica and fissura in *Heisshygia* spp. Fig. 18. *H. amplissima.* Fig. 19. *H. rolstoni.* Figs. 20–24. Female genital segments of *Heisshygia* spp. Figs. 20, 21. Posterior view. Fig. 20. *H. rolstoni.* Fig. 21. *H. amplissima.* Figs. 22–24. Lateral view. Fig. 22. *H. cephalota.* Fig. 23. *H. rolstoni.* Fig. 24. *H. amplissima.* Fig. 25. Spermatheca of *H. rolstoni.*

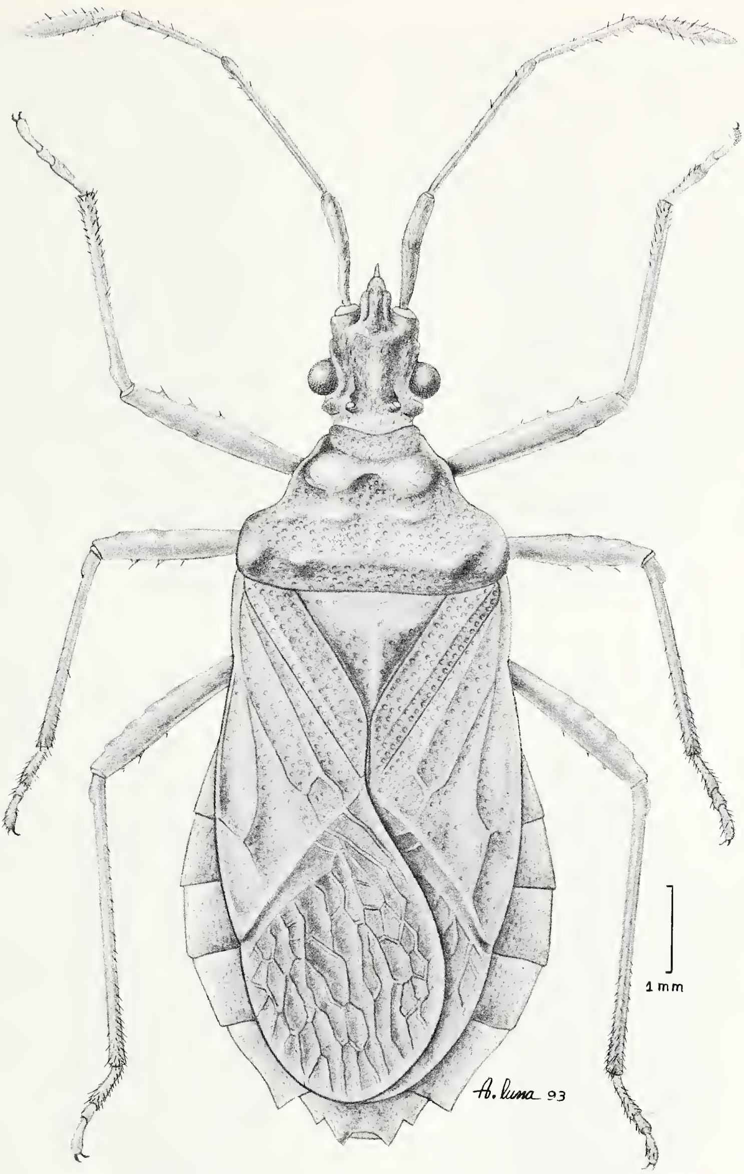
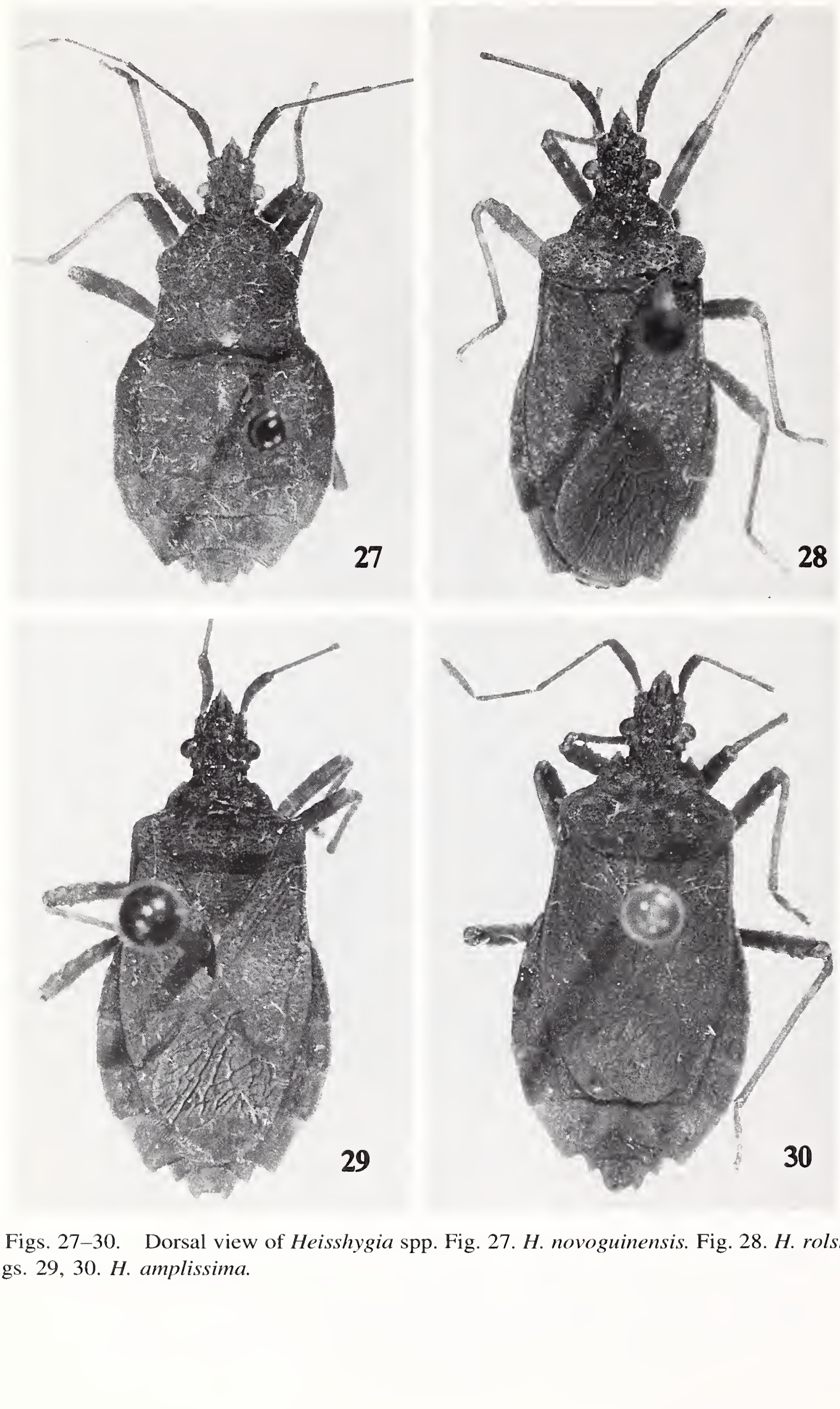


Fig. 26. Dorsal view of *Heisshygia rolstoni*.

pentagonal, clearly longer than wide, antenniferous tubercles with short lateral lobes like projections, hemelytra micropterous, widely separated from each other, leaving the abdomen exposed medially, scutellum with apex globose, and gonocoxae I in lateral view emarginate, with upper margin slightly convex (Figs. 1, 27).

Etymology. Named for its peculiar shape head.



Figs. 27–30. Dorsal view of *Heisshygia* spp. Fig. 27. *H. novoguinensis.* Fig. 28. *H. rolstoni.* Figs. 29, 30. *H. amplissima.*

Distribution. Known only from the type locality in New Guinea.

KEY TO THE KNOWN SPECIES OF *HEISSHYGIA* BRAILOVSKY

1. Hemelytra micropterous to staphylinoid; clavus and corium fused; ocelli obscure; pronotal disc posteriorly with deep depression 2
— Hemelytra macropterous to submacropterous; clavus and corium distinct; ocelli slightly tuberculate; pronotal disc posteriorly without depression 3
2. Head pentagonal, clearly longer than wide; hemelytra micropterous, widely separated from each other; scutellum with apex globose . . . . *H. novoguinensis* Brailovsky
— Head subquadrate, nearly as long as wide; hemelytra staphylinoid, contiguous medially; scutellum with apex acute . . . . *H. cephalota,* new species
3. Pronotum with anterior angles narrowly rounded (Fig. 2); genital capsule of the male with the posterior margin medially produced in a short and bifurcate plate (Figs. 5, 10, 11); gonocoxae I in lateral view with upper margin broad and slightly convex (Figs. 19, 20, 23) . . . . *H. rolstoni,* new species
— Pronotum with anterior angles broadly exposed (Fig. 4); genital capsule of the male with the posterior margin projected in a medium and wide plate (Figs. 6, 8, 9); gonocoxae I in lateral view straight (Figs. 18, 21, 24) . . . . *H. amplissima,* new species

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ROLSTONOCORIS, A NEW GENUS OF NEOTROPICAL MIRIDAE (HETEROPTERA: ORTHOTYLINAE)

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Abstract.—A mirid genus, *Rolstonocoris,* and four species are all described from Mexico as new. The type species is *R. arteagensis* n. sp. from the state of Michoacan. Additional species are *R. totolapanus* n. sp. from Oaxaca, *R. xochipalensis* n. sp. from Guerrero and *R. colimai* n. sp. from Colima.

Southern Mexico contains many endemic genera and species of Miridae especially in the subfamily Orthotylinae. This particular region begins in the transverse volcanic belt and extends south and southeastward to the Isthmus of Tehuantepec. The area is recognized as a region of significant biodiversity (Ramamoorthy et al., 1993). All of the material used in this study comes from this region. Specimens of the *Rolstonocoris* were taken at lower and intermediate altitudes.

All measurements are in millimeters.

Rolstonocoris, new genus

Description. Orthotylinae, Orthotylini. Small (2.60–3.64), body shining, vertex carinate, second antennal segment incrassate apically, costal margin of wing turned somewhat downward and hemelytron more or less hyaline.

Head smooth, shining, strongly declivous, almost totally glabrous dorsally and with pale setae ventrally; vertex slightly rounded, more so between antennal sockets, posterior margin carinate; clypeus enlarged and appearing somewhat bulbous, weakly delimited from frons; eyes located at rear of head; each antennal socket touching adjacent eye; antennal segment I shorter than vertex width; segment II incrassate apically in both sexes; relative lengths of 1–4 from shortest to longest 1–4–3–2, vestiture semierect, not longer than diameter of segment to which attached; rostrum reaching midcoxae and frequently hind coxae. Pronotum smooth, occasionally with minute shallow depressions but not clearly definable punctures, shining, almost completely glabrous; collar lacking; calli weakly delimited; lateral margins rounded, posterior margin more or less straight; covering mesoscutum. Scutellum almost flat, glabrous, shining. Hemelytron smooth, shining, somewhat hyaline, almost glabrous with a few scattered erect hairs, costal margin turned somewhat downward; embolium clearly delimited almost to apex; cuneus as wide as long or longer than wide; membrane conspicuously fuscous along margin; each tibia with several longitudinal rows of semierect setae subequal in length to diameter of tibia.

Type species, *Rolstonocoris arteagensis,* new species

This genus is named in honor of a long time friend, Larry H. Rolston.

The color pattern of the adults, although variable, is consistent among the *Rolstonocoris* species and therefore is of little value in the separation or identification of the species.

The genus sharing the most characters with *Rolstonocoris* is *Fulgenticapsus* Schaffner (1979) which occurs in the northeastern region of the state of Oaxaca and the adjacent area of Puebla. Species of both genera are relatively small in size and share the same body shape characterized by having the hemelytron curving downward along the costal margin making the dorsal surface of the insect appear somewhat rounded laterally. Members of both genera are shining and are usually sparsely setose. In addition, both have a sharply declivent head; clypeus weakly divided from frons, posterior margin of the vertex carinate; surface of the pronotum smooth and the scutellum is flat and prominent. Members of both genera have processes on the male genital capsule.

The clypeus of *Rolstonocoris* species is more prominent than that of *Fulgenticapsus* species and the second antennal segment is relatively short and clavate whereas it is longer and linear in *Fulgenticapsus.* The right male paramere of *Rolstonocoris* species is unusually elongate although usually curved.

Species of *Rolstonocoris* can be separated easily by the shape of projections on the male genital capsule, shape of the parameres, especially the right one and by the vesica. Females require dissection and the posterior wall and rings offer excellent characters for separation of the species. An unnamed structure (Figs. 25–28) located at the base of the rami of the ovipositer is also species specific. The structure is lightly sclerotized and considered here to be a gland.

Rolstonocoris arteagensis, new species
(Figs. 1–7, 25, 26)

Male (measurements taken from 20 specimens; those of holotype given first followed in parentheses by average and ranges): Length, 3.26 (3.25, 3.10–3.40); width, 1.44 (1.43, 1.38–1.48). Head length, 0.20 (0.20, 0.16–0.22); width through eyes, 0.74 (0.76, 0.74–0.78); vertex width, 0.34 (0.32, 0.30–0.34). Length of antennal segment I, 0.22 (0.22, 0.20–0.24); II, 0.94 (0.93, 0.88–1.00); III, 0.70 (0.69, 0.66–0.78); IV, 0.46 (0.45, 0.42–0.48). Pronotal length, 0.68 (0.69, 0.66–0.72); width across base, 1.14 (1.14, 1.10–1.20). Cuneal length, 0.58 (0.55, 0.50–0.58); width across base, 0.48 (0.47, 0.44–0.48).

General coloration yellowish brown with fuscous areas and usually red markings. Head yellowish brown, pale beneath; clypeus shining black; jugum and lorum occasionally tinted reddish orange; antennal segment I pale with fuscous or reddish fuscous ring at apex, segment II pale at base becoming fuscous and then almost black apically, segments III and IV pale, light fuscous apically; rostrum pale, fuscous at apex; labrum black. Pronotum uniformly yellowish brown, frequently pale along posterior margin. Scutellum uniformly yellowish brown. Hemelytron yellowish brown with variously developed reddish line paralleling area of radial vein; costal margin dark fuscous, claval suture usually dark fuscous at least in part and area between suture and radial vein light to dark fuscous with coloration extending onto largest areolar cell; membrane dark fuscous along margins, lighter fuscous centrally. Underside of thorax light fuscous to fuscous ventrally. Procoxae uniformly pale,

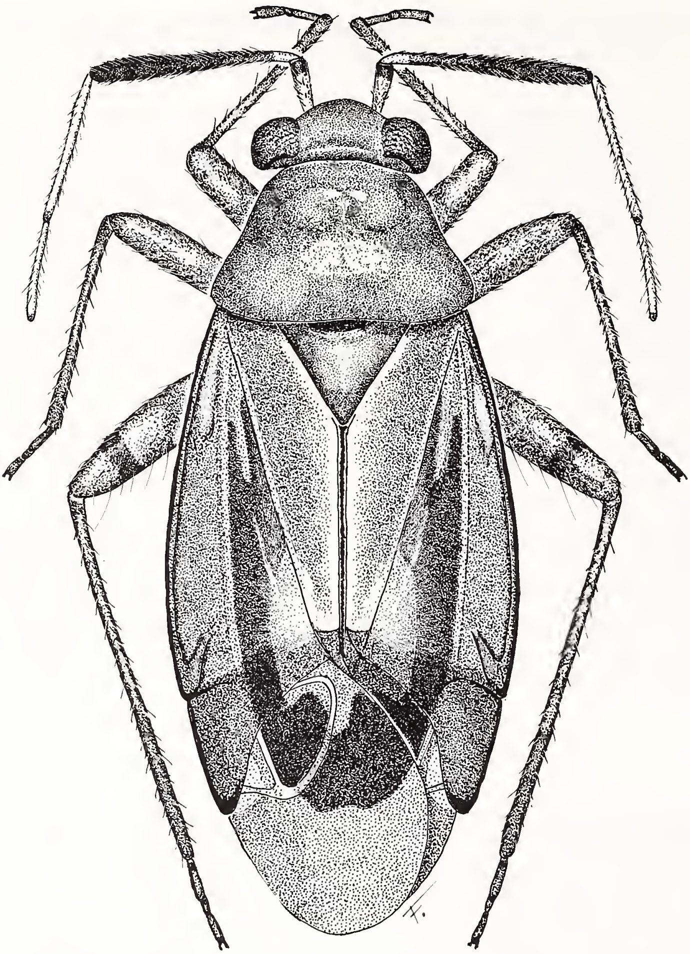
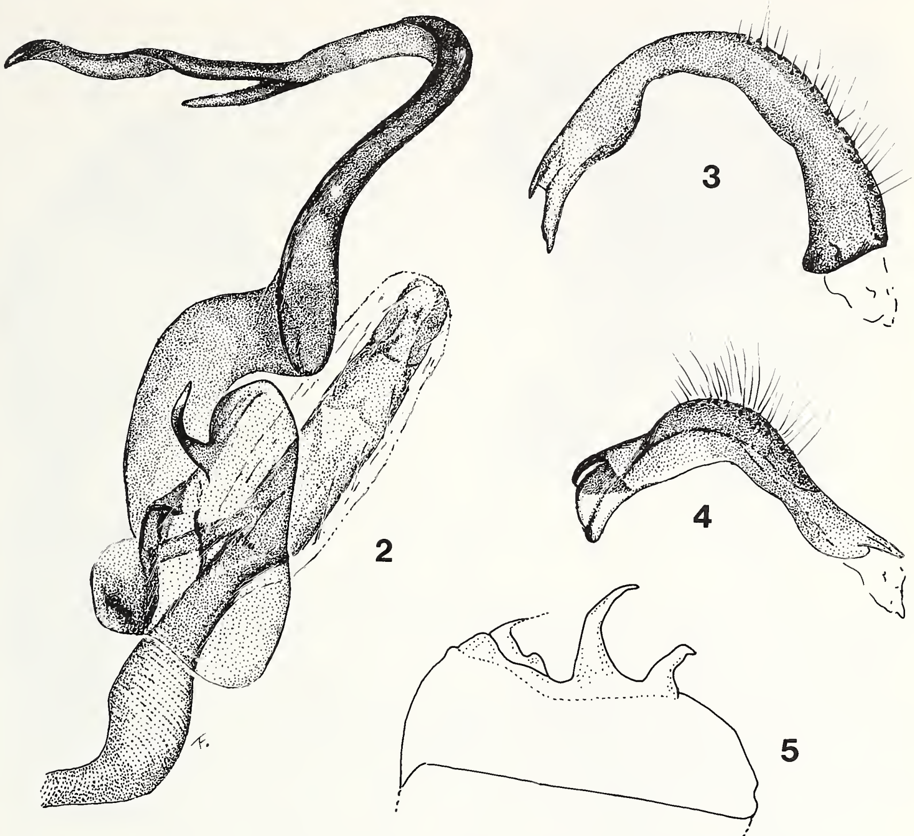


Fig. 1. *Rolstonocoris arteagensis,* male, dorsal habitus.

meso and metacoxae fuscous basally; femora pale, usually with irregular fuscous or red spot on apical half; each tibia pale sometimes with faint red marking basally; tarsi pale, becoming light fuscous at apices. Abdomen fuscous to almost black, genital capsule lighter.

Genitalia as figured (Figs. 2–5); posterio-dorsal margin of genital capsule with two processes, mesad process longest; right paramere curved, bifurcate at apex.

Female (measurements taken from 20 specimens; those of allotype given first followed in parentheses by average and ranges): Length, 3.54 (3.47, 3.24–3.64); width, 1.52 (1.53, 1.46–1.60). Head length, 0.22 (0.21, 0.20–0.26); width through eyes, 0.76 (0.77, 0.70–0.82); vertex width, 0.34 (0.35, 0.34–0.36). Length of antennal segment I, 0.22 (0.23, 0.20–0.28); II, 0.94 (0.94, 0.80–0.98); III, 0.70 (0.69, 0.60–0.72); IV, 0.42 (0.44, 0.42–0.46). Pronotal length, 0.70 (0.72, 0.62–0.78); width



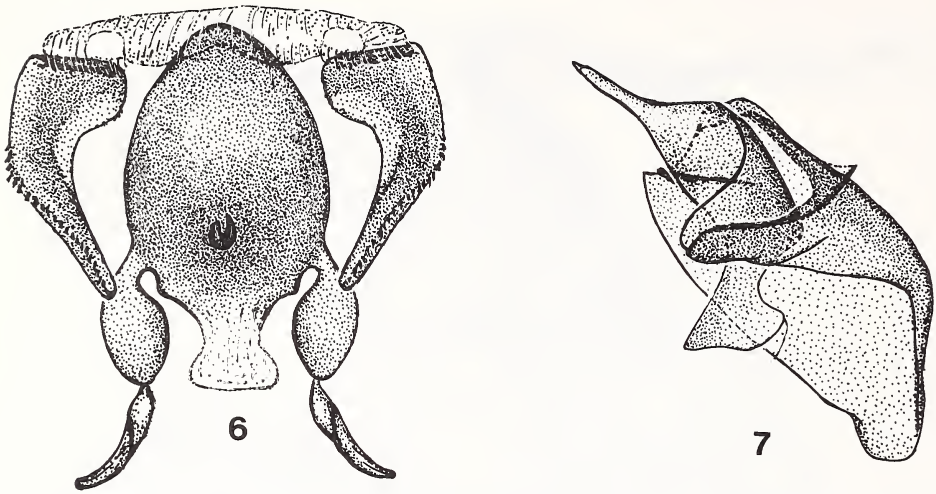
Figs. 2–5. *Rolstonocoris arteagensis,* male genitalia. 2. Vesica. 3. Right paramere, lateral view. 4. Left paramere, lateral view. 5. Genital capsule, dorsal view.

across base, 1.18 (1.18, 1.06–1.26). Cuneal length, 0.54 (0.54, 0.48–0.60); width across base, 0.48 (0.47, 0.44–0.50).

Similar to male in color and form; genitalia figured (Figs. 6, 7, 25, 26).

Holotype male: MEXICO: Michoacan, 18.8 mi ne. Arteaga, July 31, 1988, 3,000′, Ferreira, Schaffner. Deposited in the collection of the Instituto de Biologia, Universidad Nacional Autonoma de Mexico, Mexico City, D. F. Allotype female, same data and depository as holotype. Paratypes: male, 6 females, same data as holotype; 20 males, 32 females, MEXICO: Michoacan, 22 miles ne. Arteaga, July 31, 1988, 3,100′, Ferreira, Schaffner; 19 males, 12 females, MEXICO: Michoacan, 16.3 miles north of Nueva Italia, July 31, 1988, Ferreira, Schaffner. Deposited in the collections of U. N. A. M. and Texas A&M University.

This is the largest species of the genus. All specimens available for study were 3.10 or more in length., the average being 3.26. The average length of the males of the other three species is less than 3.00 although a single specimen of *R. totolapanus* measured 3.00. The females are larger than the males of the species. The average



Figs. 6, 7. *Rolstonocoris arteagensis,* female genitalia. 6. Dorsal wall. 7. Right sclerotized ring, lateral view.

length of *R. arteagensis* is 3.46 contrasted with 3.04 for both *R. colimai* and *R. totolapanus.*

The second antennal segment of the male is relatively longer than in other species and is 2.9 times as long as the vertex width. The closest ratio is that of *R. colimai* which is 2.7 longer than the vertex. In the case of the females, the second antennal segment is relatively shorter than that of the male. The segment is 2.7 times longer than the vertex for *R. arteagensis* and only 2.4 times as long in the case of *R. colimai.*

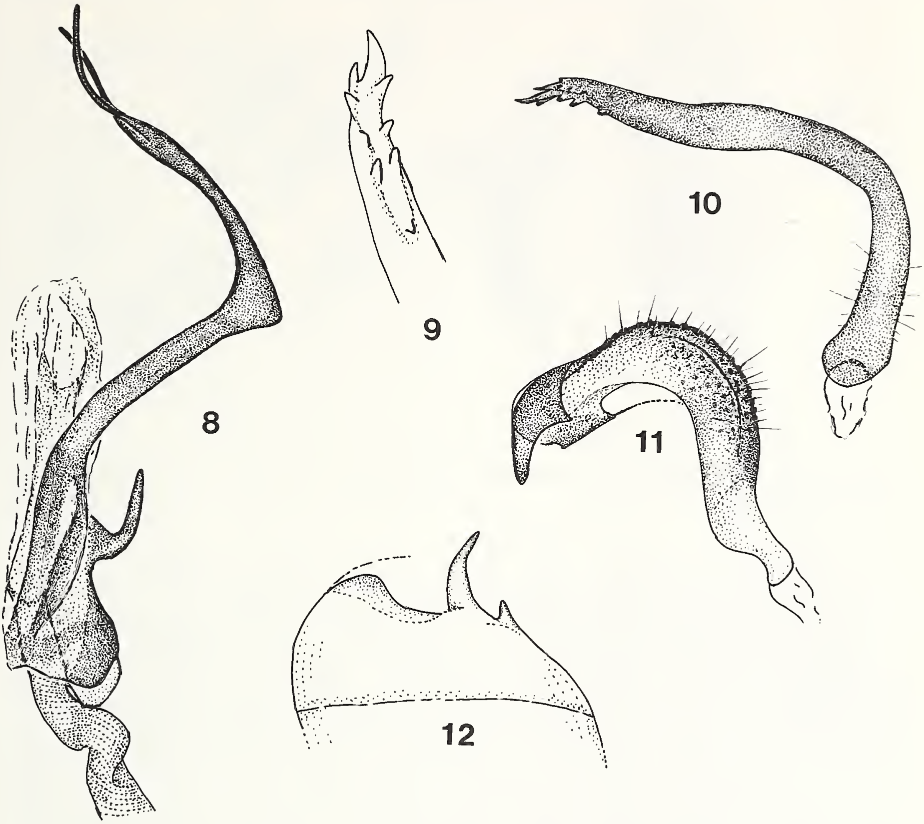
All specimens were taken from a species of plant belonging to the genus *Croton* L. (Euphorbiaceae) which was growing in pastured areas.

The species is named after the town located in the state of Michoacan near which the specimens were collected.

Rolstonocoris totolapanus, new species
(Figs. 8–14, 27)

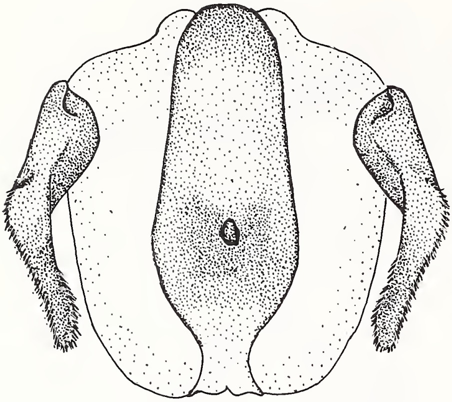
Male (measurements taken from 18 specimens; those of holotype given first followed in parentheses by average and ranges): Length, 2.74 (2.80, 2.64–3.00); width, 1.40 (1.39, 1.30–1.52). Head length, 0.18 (0.18, 0.16–0.22); width through eyes, 0.72 (0.71, 0.68–0.74); vertex width, 0.34 (0.33, 0.32–0.34). Length of antennal segment I, 0.20 (0.20, 0.18–0.22); II, 0.80 (0.77, 0.70–0.82); III, 0.52 (0.54, 0.48–0.60); IV, 0.40 (0.35, 0.28–0.40). Pronotal length, 0.64 (0.62, 0.60–0.64); width across base, 1.14 (1.10, 1.02–1.18). Cuneal length, 0.48 (0.47, 0.44–0.50); width across base, 0.48 (0.48, 0.44–0.50).

General coloration orange to reddish orange with fuscous areas and red markings. Head orange or reddish orange, paler beneath; clypeus shining black; jugum and lorum reddish; antennal segment I pale with fuscous or reddish fuscous ring at apex, segment II variable, pale at base becoming dark fuscous apically, frequently with



Figs. 8–12. *Rolstonocoris totolapanus,* male genitalia. 8. Vesica. 9. Apex of right paramere, ventral view. 10. Right paramere, lateral view. 11. Left paramere, lateral view. 12. Genital capsule, dorsal view.

reddish coloration before becoming dark fuscous, segments III and IV pale, fuscous apically; rostrum pale, fuscous at apex; labrum black. Pronotum uniformly orange to reddish orange, frequently pale along posterior margin. Scutellum uniformly orange or reddish orange. Hemelytron more or less orange with reddish line paralleling area of radial vein; costal margin dark fuscous and usually a variable region on and paralleling claval suture light fuscous to fuscous, with coloration extending onto largest areolar cell; membrane light fuscous with outer margin always darker; cuneus orange to reddish orange usually slightly darker at apex. Underside reddish orange with pleural and sternal areas occasionally tinged with fuscous. Procoxae uniformly pale, meso and metacoxae frequently light fuscous at base, remainder pale; femora pale basally becoming light fuscous apically, each usually with an elongate reddish spot on apical half; tibiae uniformly pale or light fuscous basally, each often with reddish streak on outer margin near base; tarsi pale becoming light fuscous at apices. Underside of abdomen orange or reddish orange to fuscous, genital capsule lighter.



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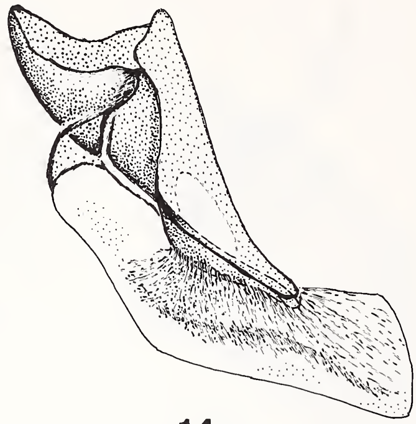

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Figs. 13, 14. *Rolstonocoris totolapanus,* female genitalia. 13. Dorsal wall. 14. Right sclerotized ring, lateral view.

Genitalia as figured (Figs. 8–12); posterio-dorsal margin of genital capsule with one long and one short process; right paramere dentate at apex.

Female (measurements taken from 17 specimens; those of allotype given first followed in parentheses by average and ranges): Length, 3.10 (3.05, 2.86–3.22); width, 1.36 (1.41, 1.36–1.50). Head length, 0.20 (0.19, 0.16–0.20); width through eyes, 0.70 (0.72, 0.70–0.74); vertex width, 0.34 (0.36, 0.32–0.40). Length of antennal segment I, 0.20 (0.20, 0.18–0.22); II, 0.78 (0.79, 0.72–0.84); III, 0.54 (0.57, 0.52–0.58); IV, 0.40 (0.37, 0.34–0.40). Pronotal length, 0.60 (0.61, 0.56–0.64); width across base, 1.06 (1.10, 1.04–1.14). Cuneal length, 0.48 (0.47, 0.42–0.50); width across base, 0.46 (0.47, 0.44–0.50).

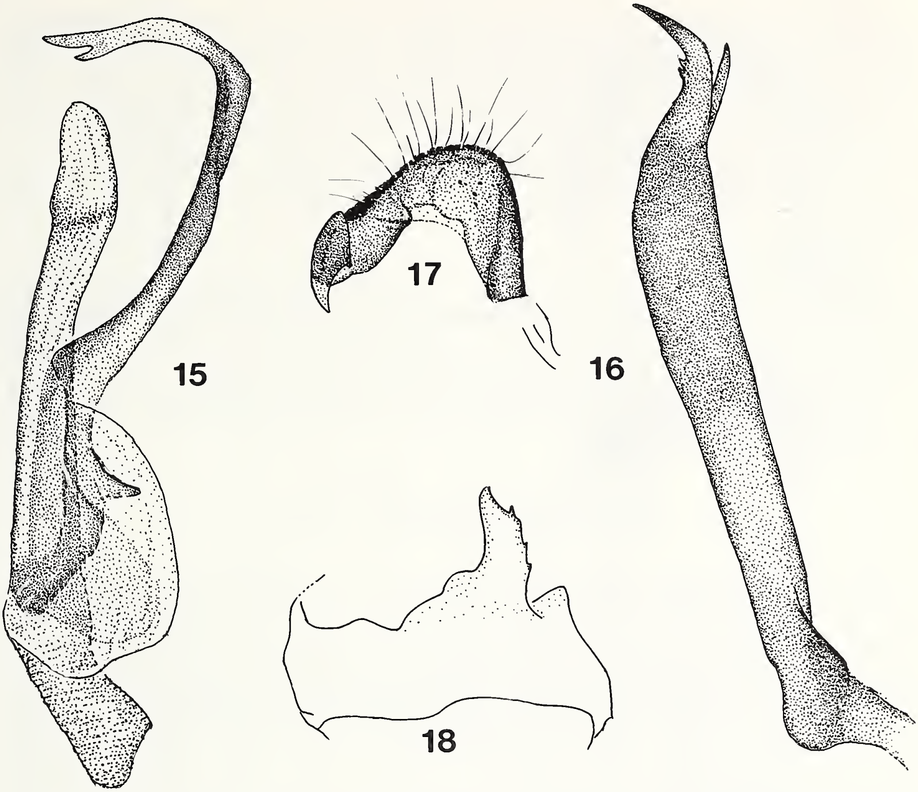
Similar to male in color and form; genitalia figured (Figs. 13, 14, 27).

Holotype male: MEXICO: Oaxaca, 10 mi. e. Totolapan, elev. 4,000 ft, July 20, 1987, Kovarik, Schaffner. Deposited in the collection of the Instituto de Biologia, Universidad Nacional Autonoma de Mexico, Mexico City, D. F. Allotype female, same data and depository as holotype. Paratypes: 14 males, 13 females, same data as holotype; male, MEXICO: Oaxaca, 2.1 mi. nw Totolapan, July 11–17, 1981, Bogar, Schaffner, Friedlander; female, 8 mi e. Totolapan, Kovarik, Schaffner; male, female, MEXICO: Oaxaca, 1 mi se. Rio Hondo, July 22, 1974, Clark, Murray, Ashe, Schaffner; male, female, MEXICO: Puebla, 5 mi southeast of Izucar de Matamoros, July 20, 1984, Carroll, Schaffner, Friedlander. Deposited in the collections of U. N. A. M. and Texas A&M University.

This species is named after the town located in the state of Oaxaca near which the specimens were collected.

Rolstonocoris xochipalensis, new species
(Figs. 15–18)

Male (measurements taken from three specimens; those of holotype given first followed in parentheses by average and ranges): Length, 2.70 (2.82, 2.70–2.94);



Figs. 15–18. *Rolstonocoris xochipalensis,* male genitalia. 15. Vesica. 16. Right paramere, lateral view. 17. Left paramere, lateral view. 18. Genital capsule, dorsal view.

width, 1.48 (1.49, 1.44–1.54). Head length, 0.16 (0.16, 0.14–0.16); width through eyes, 0.74 (0.72, 0.70–0.74); vertex width, 0.36 (0.34, 0.32–0.36). Length of antennal segment I, 0.20 (0.20, 0.20–0.22); II, 0.84 (0.81, 0.78–0.84); III, 0.56 (0.57, 0.56–0.60); IV, 0.32 (0.35, 0.32–0.38). Pronotal length, 0.68 (0.66, 0.64–0.68); width across base, 1.20 (1.19, 1.18–1.20). Cuneal length, 0.52 (0.53, 0.52–0.54); width across base, 0.44 (0.45, 0.44–0.46).

General coloration orange to reddish orange with fuscous areas and red markings. Head orange to reddish orange, paler beneath; clypeus shining black; jugum and lorum reddish; antennal segment I pale with fuscous or reddish fuscous ring at apex, segment II variable, pale basally and becoming dark fuscous apically, segments III and IV pale, light fuscous apically; rostrum pale with basal area of segment I and apex of rostrum fuscous; labrum black. Pronotum uniformly orange to reddish orange, posterior margin narrowly pale or white. Scutellum uniformly orange to reddish orange. Hemelytron orange to reddish orange especially basally, remainder pale, with reddish line paralleling radial vein; costal margin fuscous, claval suture in part fuscous and with longitudinal fuscous line or area between suture and radial vein

extending onto largest areolar cell; membrane dark fuscous along margins, lighter fuscous centrally. Underside of thorax reddish orange becoming fuscous ventrally. Procoxae uniformly pale, meso and metacoxae fuscous basally; femora pale, each with irregular fuscous or red spot on apical half; tibiae pale, each with faint red marking basally. Abdomen yellowish brown to fuscous, usually darker basally.

Genitalia as figured (Figs. 15–18); posterio-dorsal margin of genital capsule with broad irregular projection instead of process; right paramere almost straight, bifurcate at apex.

Female unknown.

Holotype male: MEXICO: Guerrero, 6 miles east of Xochipala, July 13, 1985, Jones, Schaffner. Deposited in the collection of the Instituto de Biologia, Universidad Nacional Autonoma de Mexico, Mexico City, D. F. Paratypes: 2 males, same data as holotype. Deposited in the collection of Texas A&M University.

The species is named after the town located in the state of Guerrero near which the specimens were collected.

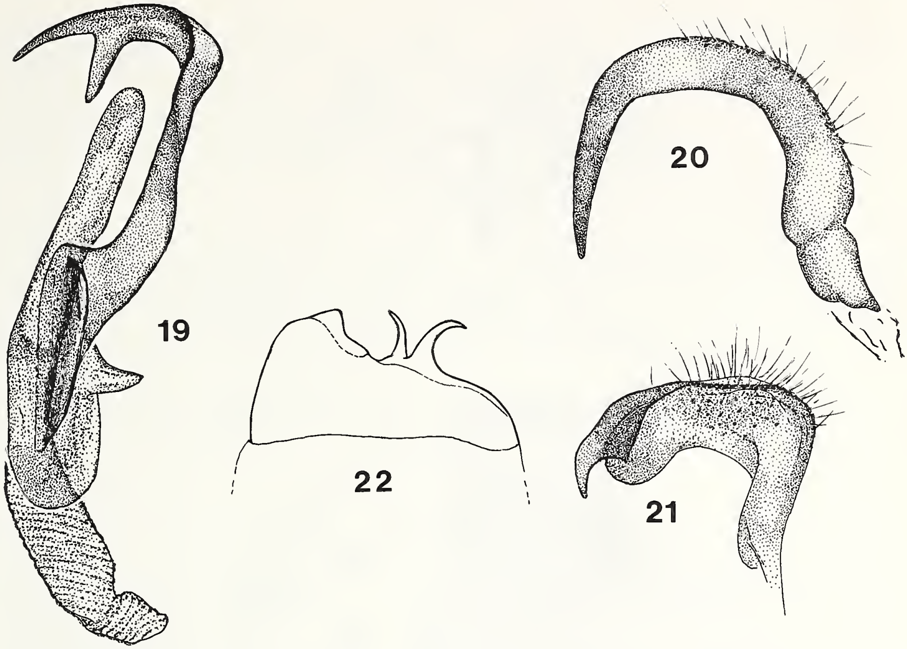
Rolstonocoris colimai, new species
(Figs. 19–24, 28)

Male (measurements taken from nine specimens; those of holotype given first followed in parentheses by average and ranges): Length, 2.68 (2.70, 2.60–2.86); width, 1.36 (1.32, 1.26–1.36). Head length, 0.14 (0.16, 0.14–0.20); width through eyes, 0.74 (0.72, 0.68–0.74); vertex width, 0.32 (all). Length of antennal segment I, 0.20 (0.19, 0.18–0.20); II, 0.86 (0.81, 0.78–0.86); III, 0.60 (0.62, 0.56–0.68); IV, 0.36 (0.38, 0.32–0.40). Pronotal length, 0.66 (0.62, 0.60–0.66); width across base, 1.10 (1.06, 1.02–1.10). Cuneal length, 0.46 (0.46, 0.44–0.48); width across base, 0.44 (0.42, 0.40–0.44).

General coloration yellowish brown to orange with fuscous areas and red markings. Head yellowish brown, slightly paler beneath; clypeus shining dark fuscous to black; jugum and lorum usually with reddish coloration; antennal segment I pale with reddish fuscous to fuscous ring at apex, segment II pale basally becoming dark fuscous apically, segments III and IV pale, light fuscous apically; rostrum pale, fuscous at apex; labrum black. Pronotum yellowish brown to orange, posterior margin pale to white. Scutellum uniformly yellowish brown to orange. Hemelytron yellowish brown to orange, usually with reddish area paralleling radial vein; costal margin of embolium fuscous, claval suture in part fuscous and with longitudinal line between suture and radial vein extending onto largest areolar cell, clavus sometimes tinged with fuscous; membrane darker fuscous along margins, lighter fuscous centrally. Underside of thorax light fuscous to yellowish brown. Procoxae uniformly pale, meso and metacoxae fuscous basally; femora pale basally becoming light fuscous apically, each with elongate reddish spot on apical half; tibiae pale with reddish markings near base; tarsi pale becoming light fuscous at apices. Abdomen reddish brown to dark fuscous, genital chamber lighter yellowish brown.

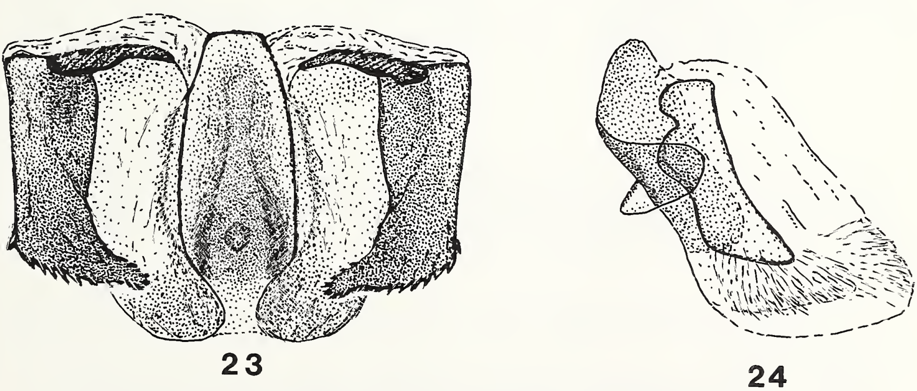
Genitalia as figured (Figs. 19–22); posterio-dorsal margin of genital capsule with two processes of about equal length; right paramere curved, apex pointed.

Female (measurements taken from seven specimens; those of allotype given first followed in parentheses by average and ranges): Length, 2.96 (3.04, 2.88–3.20);

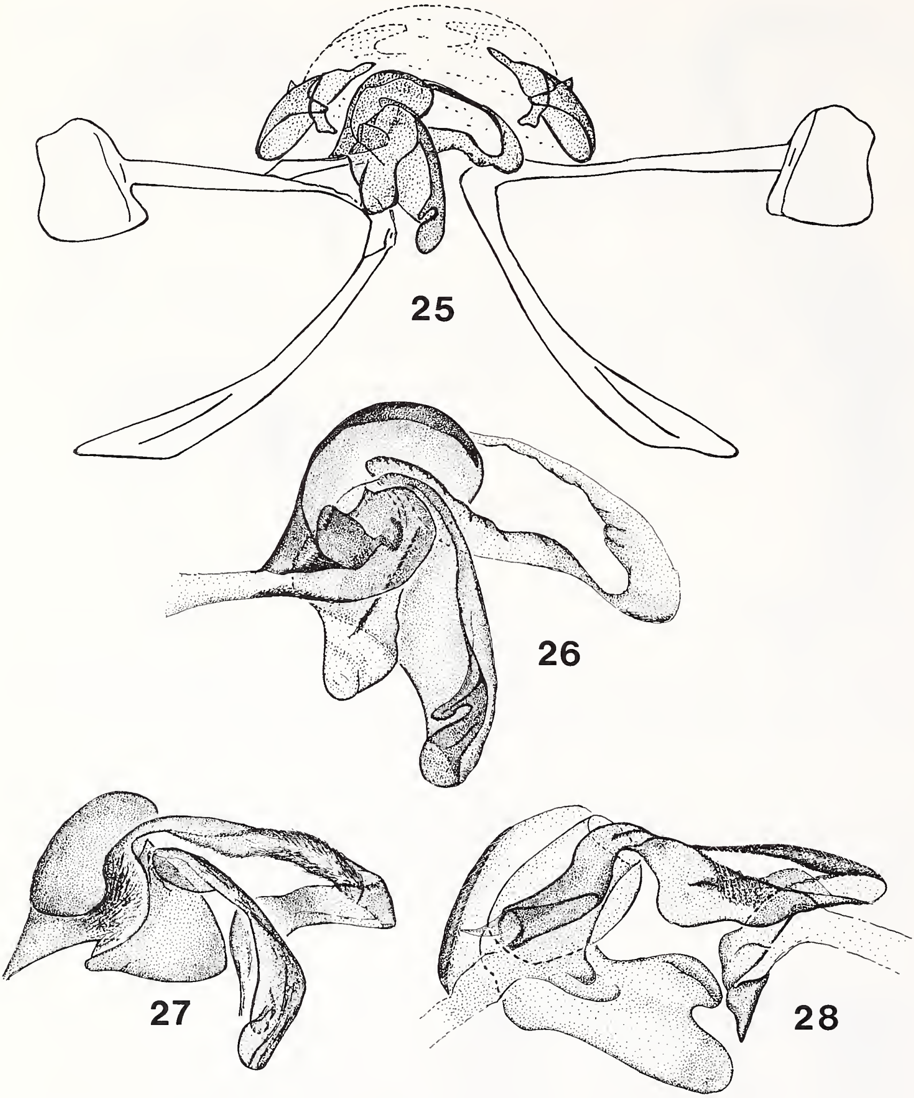


Figs. 19–22. *Rolstonocoris colimai,* male genitalia. 19. Vesica. 20. Right paramere, lateral view. 21. Left paramere, lateral view. 22. Genital capsule, dorsal view.

width, 1.44 (1.44, 1.36–1.54). Head length, 0.14 (0.16, 0.14–0.22); width through eyes, 0.72 (0.74, 0.72–0.76); vertex width, 0.34 (0.34, 0.34–0.36). Length of antennal segment I, 0.20 (0.22, 0.20–0.22); II, 0.78 (0.82, 0.78–0.88); III, 0.56 (0.60, 0.56–0.62); IV, 0.36 (all). Pronotal length, 0.64 (0.66, 0.64–0.66); width across base, 1.10



Figs. 23, 24. *Rolstonocoris colimai,* female genitalia. 23. Dorsal wall. 24. Right sclerotized ring, lateral view.



Figs. 25–28. Glandular structure of female. 25. *Rolstonocoris arteagensis,* posterior view of glandular structure in relation to anterior valvulae. 26. *Rolstonocoris arteagensis.* 27. *Rolstonocoris totolapanus.* 28. *Rolstonocoris colimai.*

(1.10, 1.08–1.10). Cuneal length, 0.46 (0.48, 0.46–0.50); width across base, 0.44 (0.46, 0.44–0.48).

Similar to male in coloration and form; genitalia figured (Figs. 23, 24, 28).

Holotype male: MEXICO: Colima, 6 mi south Colima, August 3, 1988, Ferreira, Schaffner. Deposited in the collection of the Instituto de Biologia, Universidad Na-

cional Autonoma de Mexico, Mexico City, D. F. Allotype female, same data and depository as holotype. Paratypes: 8 males, 6 females, same data as holotype. Deposited in the collections of U. N. A. M. and Texas A&M University.

This species is named after the indians who inhabit the area where the specimens were collected and after whom the state and city were named.

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ADEVOPLITUS, A NEW GENUS OF NEOTROPICAL PENTATOMINI (HETEROPTERA, PENTATOMIDAE)

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Abstract.—*Adevoplitus*, n. gen. is proposed for the previously described species *Pseudevoplitus longicornis* Ruckes, *P. casei* Thomas, and *P. mexicanus* Brailowsky & Barrera. Two new species are also described *Adevoplitus venezolanus*, n. sp. and *A. costaricensis*, n. sp. from Venezuela and Costa Rica respectively. Previously known species are redescribed herein, and a key is provided for the identification of all known species.

Key words: Pentatomidae, *Adevoplitus*, neotropical, taxonomy, stink bug.

Grazia et al. (1994), in their recent review of *Pseudevoplitus* Ruckes removed three species (*P. casei* Thomas, *P. longicornis* Ruckes, *P. mexicanus* Brailovsky and Barrera) from *Pseudevoplitus.* We are erecting a new genus, *Adevoplitus,* for this group of species. We are also describing two new species, *A. venezolanus* from Venezuela, and *A. costaricensis* from Costa Rica. This proposition is based in the study of the morphology of genitalia of both sexes, as well as on the distinct characters of general morphology. Indeed, the five species of *Adevoplitus* are very similar, the differences being mostly found in the structure of genitalia.

Adevoplitus occurs primarily in the northern part of Neotropical Region, being found in Mexico and Central America. Only one species, *A. venezolanus* is record for South America.

To Dr. Larry H. Rolston, to whom this paper is offered, in recognition to his great contribution to the knowledge of the pentatomids.

MATERIALS AND METHODS

Measurements are given in millimeters and are taken as indicated in Grazia *et al.* (1994). The terminology of Dupuis (1970), and Schaefer (1977) was adopted for the structure of the genitalia. The dissected genitalia were cleared with 10% KOH and stained with Congo Red.

A significant series of the previously described species was also examined so the opportunity to dissect the genitalia of both sexes was available; descriptions and illustrations of the genitalia of *A. longicornis, A. casei,* and *A. mexicanus* are given. For the description and illustration of the median excavation of the ventral rim of the pygophore, the whole segment was tilted slightly posteriorly; for the sake of clarity the infolding of the ventral rim of the pygophore is omitted in Figs. 16–20.

Specimens are deposited in the following institutions with their acronyms as they appear in the text: AMNH—American Museum of Natural History, New York, NY; DAR—David A. Rider Collection, Fargo, ND; DBT—Donald B. Thomas collection, Weslaco, TX; DZRS—Departamento de Zoologia, Universidade Federal do Rio Grande do Sul, Porto Alegre RS, Brazil; LACM—Los Angeles County Museum of

Natural History, Los Angeles, CA; MCNZ—Museu de Ciencias Naturais, FZBRS, Porto Alegre RS, Brazil; NMNH—National Museum of Natural History, Washington D.C.; UNAM—Colecion Entomologica del Instituto de Biologia, Universidad Nacional Autonoma de Mexico, Mexico D.F.

KEY TO THE GENERA

1. Antero-lateral margins of pronotum with anterior half crenulate or subtuberculate, concave, not thinly emarginate. Humeral angles strongly spinose. 2
— Antero-lateral margins of pronotum entire, essentially straight, thinly emarginate. Humeral angles acute, triangular, not strongly spinose. . . . . *Adevoplitus* n. gen.
2. Apex of scutellum entire; veins of membrane parallel. Ostiolar rugae short, each not reaching lateral margin of metapleuron. . . . . *Pseudevoplitus* Ruckes
— Apex of scutellum bilobate. Veins of membrane reticulate. Ostiolar rugae long, each reaching lateral margin of metapleuron. . . . . *Evoplitus* Amyot & Serville.

Adevoplitus, new genus

Type species: *Pseudevoplitus longicornis* Ruckes, 1958

Head porrect, margins mildly reflexed, abruptly sinuate before eyes then parallel or divergent to truncately rounded apex. Juga and tylus equal in length. Ocelli prominent, bright red, twice as far apart as each is from adjacent eye; eyes fuscous, large, subglobular, and protruding but not exceeding beyond anterior pronotal margins. Antennae exceptionally long, subequal to medial length from apex of head to apex of scutellum; segment I surpassing apex of head, segment IV longest, segments II and V subequal, each more than twice the length of segment I. Bucculae moderately prominent, subrectilinear in profile, margins elevated anteriorly, parallel there, then gradually becoming lower, sometimes evanescent at base, in ventral view, divergent posteriorly. Rostrum fulvous, only extreme apex piceous; segment I enclosed by bucculae; segment II arcuate, surpassing procoxae; segment III longest, reaching or surpassing metasternum; last two segments dorso-ventrally depressed.

Pronotum nearly two and one half times as wide across humeri as long medially; anterior margin shallowly excavated, subtruncate behind eyes, with shallow submarginal sulcus, each anterior angle minutely denticulate; humeral angles acute not strongly produced; antero-lateral margins essentially straight, thin, narrowly reflexed; posterior margin broad, shallowly sinuate; disc moderately convex, anterior portion mildly declivous, weakly impressed near middle of antero-lateral margins.

Scutellum somewhat longer than wide at base; basal angles subfoveolate, piceous. Apex of scutellum attaining, or nearly attaining an imaginary line across postero-lateral angles of hemelytra. Frenum ending at or slightly beyond middle of scutellum. Margins of scutellar tongue gradually converging to acute apex.

Basal fourth of costal margins of hemelytra reflexed; posterolateral angles acutely rounded; suture of membrane bisinuate; membrane reaching apex of abdomen, irregularly infuscated, with 7 or 8 subparallel veins.

Mesosternal carina reaching prosternum, strongly compressed between procoxae. Metasternal plate raised, hexagonal, posterior margin excavated in triangular notch to receive antrorse protuberance of third abdominal segment. Each ostiolar ruga

extending more than halfway across metapleuron, slightly elevated and curved anteriorly, margins subparallel, apex abruptly, obtusely rounded.

Legs with tibiae dorsally sulcate.

Connexivum well exposed, apical angles acute, produced; seventh connexival plate provided with superimposed, retrorse, acute projection; segments III to VI each with superimposed minute tubercle or spine mesial to each apical angle.

Abdominal medialkeel well developed, terminating anteriorly in stout subconical tubercle; crest of keel narrowly dark brown, in males dilating on seventh sternite. Spiracles oval.

Male genitalia. Pygophore widely open, anterior chamber of genital capsule ample; dorsal rim deeply excavated, fully exposing tenth segment (proctiger); postero-lateral angles expanded; middle third of ventral rim deeply excavated; infolding of ventral rim forming medial 1 + 1 breast-like expansions that are close together, dorsally produced. Diaphragm with pair of strongly sclerotized, elongate, plate-like processes, extending horizontally from dorsal rim of pygophore to base of paramere. Diaphragm very finely striated, striae parallel. Parameres elongate, horizontally arranged along plate-like processes of diaphragm. Longitudinal axis of proctiger perpendicular to sagital plane of pygophore so that anal tube opens ventrally. Basal part of proctiger expanded laterally into 1 + 1 process that encircles tube dorsally and laterally. *Phallotheca* cylindrical, opening posteriorly, with two processes: basal one (*processus phallothecae* 1), subrectangular, posterior margin notched medially; distal one (*processus phallothecae* 2), large, arm-like, beginning at distal aperture of *phallotheca* dorsally projected, nearly perpendicular to longitudinal axis. Dorsal surface of *phallotheca* between *processus phallothecae* 1 and 2, irregular, in lateral view suggesting 1 to 3 verrucae. Basal plates of articulatory apparatus with two pairs of connectives dorsally; those with *processus capitati* compressed, large relatively to basal plates when taken together with processes. *Ponticulus transversalis* produced into long, semi-membranous sheath, lateral sides continuous with dorsal connectives. *Ductus seminis distalis* short, surrounded by voluminous vesica which projects itself dorsally into pair of relatively long, recurved arms (*processus vesicae*) bearing apical membranous flap.

Female genitalia. Imaginary transverse line touching apices of laterotergites 9 crossing sternite VII near its apex; distance from imaginary line to apex of sternite VII subequal to medial length of segment X. In profile, intersection of two imaginary planes tangential respectively to medial abdominal keel and gonocoxites 8, nearly right angle. Gonocoxites 8 rugulose along posterior border rendering them somewhat crenulate; mesial borders parallel or divergent at distal portion; postero-mesial angles well defined or continuous with posterior border. Posterior border of laterotergites 8 each sometimes produced into spine or lobe laterally. Apices of laterotergites 9 surpassing transverse band uniting laterotergites 8 dorsally. Gonocoxites 9 subrectangular, antero-lateral angles expanded into narrow arms; anterior margins sinuate, notched at middle. Thickening of vaginal intima conical, finger-like in ventral view, uniformely sclerotized. *Pars communis* forming elipsoidal area behind thickening of vaginal intima; *chitinnellipsen* present each side of ellipsoidal area. *Ductus receptaculi* before vesicular area about three times as long as ductus after this area. *Capsula seminalis* globoid, bearing three equally spaced, finger-like projections. *Pars*

Table 1. Diagnostic morphological characters in *Adevoplitus* and *Pseudevoplitus*.

Adevoplitus	*Pseudevoplitus*
1. Antero-lateral margins of pronotum entire, emarginate.	1. Antero-lateral margins of pronotum thick, obtuse, crenulate or subtuberculate.
2. Humeral angles acute, triangular.	2. Humeral angles spinose.
3. Proctiger expanded in 1 + 1 process encircling its base.	3. Proctiger with ample, almost bilobate process.
4. Diaphragm process plate-like.	4. Diaphragm process keel-like.
5. Basal plates with two pairs of connectives.	5. Basal plates with two pairs of dorsal connectives.
6. *Phallotheca* with two processes.	6. *Phallotheca* with two processes.
7. *Processus phallothecae* 2 in a stretched arm.	7. *Processus phallothecae* 2 in a stretched tongue.
8. *Processus vesicae* with membranous flaps.	8. *Processus vesicae* without membranous flaps.
9. Imaginary transverse line touching apices of laterotergites 9 crosses sternite VII near apex.	9. Imaginary transverse line touching apices of laterotergites 9 crosses sternit VII far from its apex.
10. Distance between this imaginary line to apex of sternite VII subequal to medial length of segment X.	10. Distance between this imaginary line to apex of sternite VII almost twice medial length of segment X.
11. Imaginary planes tangential to gonocoxites 8 and abdominal keel, forming nearly right angle.	11. Imaginary planes tangential to gonocoxites 8 and abdominal keel, forming obtuse angle.

intermedialis constricted about mid-length. Anterior annular crest disc-like, flange of crest inconspicuous.

Comments: The most conspicuous differences between *Adevoplitus* and *Pseudevoplitus* are in the structure of the pronotum, as well as in the morphology of the genitalia of both sexes. Table 1 lists the differences between them.

The color of the pronotum is variable among the species: ground color predominantly fulvous with irregular distributed reddish brown punctures, tending to ferrugineous behind cicatrices, forming quadrangular patches (i.e., *P. casei, P. venezolanus*), one or two semicircular lines (i.e., *P. casei, P. venezolanus*), or with a unique transversal band (i.e., *P. longicornis*), sometimes followed by a fulvous strip without punctures across humeri (i.e., *P. costaricensis*).

KEY TO THE SPECIES OF *ADEVOPLITUS*

1. In posterior view, general outline of pygophore elliptical or as biconvex lens, postero-lateral angles sometimes protruding (Figs. 6, 12). Gonocoxites 8 with mesial borders contiguous along their length, except for postero-mesial angles; lateral angles of plates attaining posterior margin of transverse band uniting laterotergites 8 dorsally (Figs. 35, 38). 2

— In posterior view, general outline of pygophore with dorsal half convex, and ventral half trapezoid, postero-lateral angles protruding (Figs. 3, 9, 15). Gonocoxites 8 with mesial borders contiguous along ¾ to ⅘ of their length, apical fourth to fifth divergent;

lateral angles of plates attaining or surpassing posterior margin of transverse band uniting laterotergites 8 dorsally (Figs. 33, 36, 40). 3

2. Ventral rim of pygophore with broadly open V-shaped medial excavation (Fig. 17). Posterior border of laterotergites 8 rectilinear, not produced into lobes (Fig. 35). . . . . *A. casei* (*Thomas*)

— Medial excavation of ventral rim of pygophore somewhat angulate resembling hexagon cut in half (Fig. 19). Posterior border of laterotergites 8 triangularly produced laterally (Fig. 38). . . . . *A. costaricensis* n. sp.

3. Apex of scutellum reaching postero-lateral angles of hemelytra. Ventral surface of pygophore provided with roundish low tumidity each side of the evenly U-shaped medial excavation of ventral rim (Fig. 20). Lateral angles of gonocoxites 8 each forming hook-like projection which reaches or surpasses transverse band uniting laterotergites 8 dorsally (Fig. 40). . . . . *A. venezolanus* n. sp.

— Apex of scutellum not reaching postero-lateral angles of hemelytra. Ventral surface of pygophore without tumidities. Lateral angles of gonocoxites 8 acute, projected forward, but not forming hook-like structures, not reaching transverse band uniting laterotergites 8 dorsally (Figs. 33, 36). 4

4. V-shaped medial excavation of ventral rim of pygophore with convex undulation midway along each arm of "V" (Fig. 16). Female with sternite VII somewhat carinate medially; gonocoxites 8 with sutural borders contiguous along ⅘ of their length, distal fifth divergent, continuous with posterior borders (Fig. 33). . . . . . *A. longicornis Ruckes*

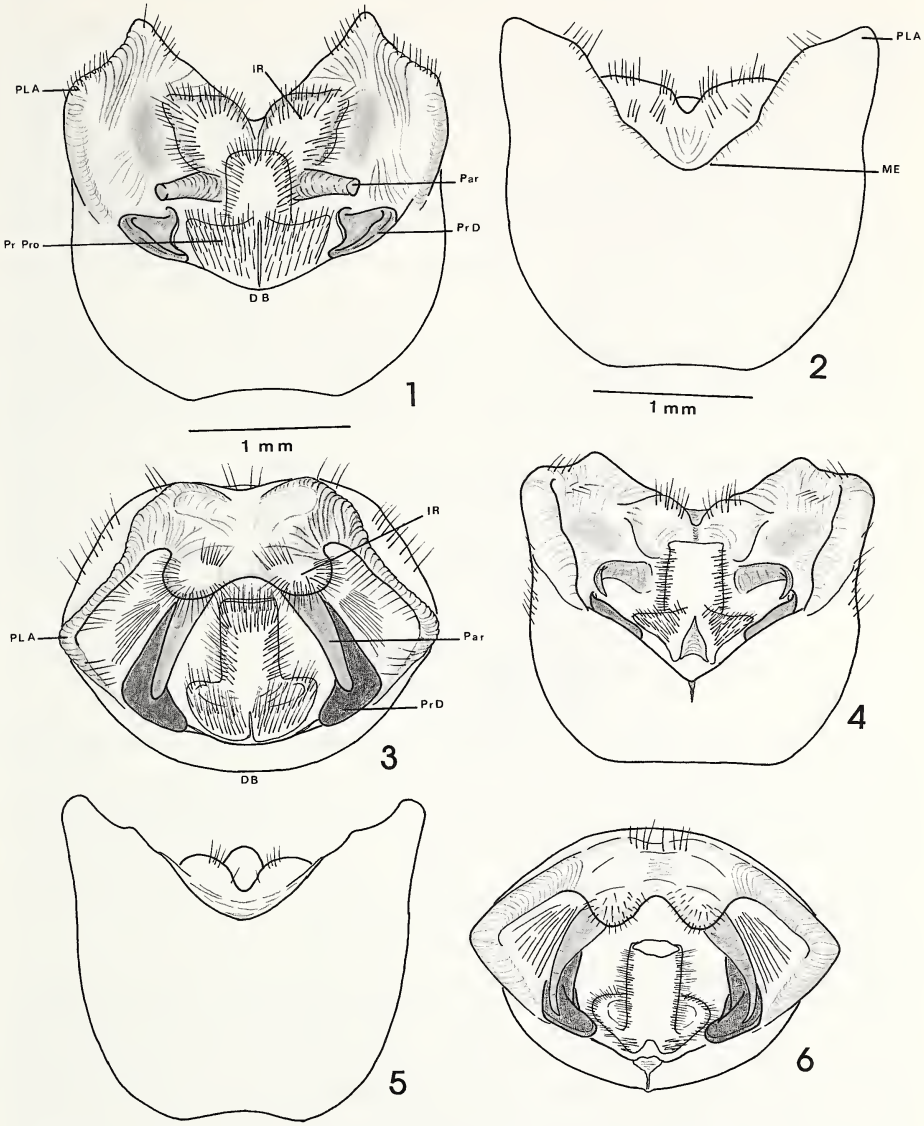
— V-shaped medial excavation of ventral rim of pygophore without undulations (Fig. 18). Female with sternite VII not medially carinate; gonocoxites 8 with mesial borders contiguous along ¾ of their length, distal fourth feebly divergent, forming narrow V-shaped notch (Fig. 36). . . . . *A. mexicanus Brailovsky & Barrera*

Adevoplitus longicornis (Ruckes), NEW COMBINATION
(Figs. 1–3, 16, 21–23, 33–34)

Pseudevoplitus longicornis Ruckes, 1959:13–17; Thomas, 1980:296; Brailovsky & Barrera, 1982:232, 236, 244–246.

Male genitalia (Figs. 1–3). General outline of pygophore in posterior view with dorsal half convex, ventral half trapezoidal, the three sides of trapezoid approximately equal; medial excavation of ventral rim V-shaped, with convex undulation midway along arm of "V" (Fig. 16). Apex of *processus phallothecae* 2 obliquely truncate, in lateral view basal process foremost. In lateral view, dorsal wall of *phallotheca* forming obtuse angle with *processus phallothecae* 2, bearing 2 evenly spaced verrucae (Figs. 21–23).

Female genitalia (Figs. 33, 34). Sternite VII somewhat carinate medially. Gonocoxites 8 nearly ⅓ longer than wide; mesial borders contiguous along ⅘ of their length, distal fifth divergent and continuous with posterior borders, forming triangle with lateral border which is convexly recurved; each lateral angle lying deep in narrow notch between laterotergites 8 and 9 resuling from carinately-elevated mesial margin of each laterotergite 8; mesial marginal areas, and particularly posterior marginal areas of gonocoxites 8 rugulose. Basal area of laterotergites 8 deeply sunk, producing gap in triangular area where posterior border of sternite VII and gonocoxite 8 meet. Posterior border of laterotergites 8 each projected laterally into acute angle; spiracles minute, not visible in resting position. Visible part of gonocoxites 9 with 1 + 1 minute verrucae, posterior border nearly rectilinear.



Figs. 1–6. Male genitalia. Pygophore in dorsal, ventral, and posterior view, respectively. 1–3. *Adevoplitus longicornis*. 4–6. *A. casei*. (DB = dorsal border, IR = infolding of ventral rim of pygophore, ME = median excavation of ventral rim of pygophore, Par = paramere, PLA = postero-lateral angles of pygophore, PrD = diaphragm process, PrPro = proctiger process).

Distribution. Panama (Canal Zone). The occurence of this species in Costa Rica (Thomas, 1980) is questionable.

Types. Holotype male deposited in AMNH was examined, labeled: (a) B[arro] C[olorado] I[sland], PANAMA, 24-V-1957, F. Schrader (b) *Pseudevoplitus longicornis* Ruckes HOLOTYPE.

Allotype female with same data as holotype, deposited in AMNH, was examined.

Paratypes, also deposited in AMNH, were examined: one male, labeled (a) Barro Colorado, C. Z., 11-III-1936, collected by Gertsch, Lutz, Wood; one male, labeled (a) B.C.I. Panama, 23-V-1957, F. Schrader; one female, labeled (a) Barro Color. Panama, 17-VI-1956, F. Schrader.

Additional material. PANAMA, Canal Zone-Barro Colorado Island: one male, IV-30-1962, H. Ruckes (AMNH); 2 males, V-1/9-1964, WD & SS Duckworth (NMNH); one male, one female, III-25/28-1965, WD & SS Duckworth (NMNH); 4 males, V-10/17-1964, WD & SS Duckworth (NMNH); one male, 9°10′N, 79°50′W, VI-3-1977, H. A. Hespenheide (AMNH); one male 9°10′N, 79°50′W, VII-14-1977, H. A. Hespenheide (AMNH); one female, Lights-Weir/SM III, V-7-1978, Coll. H. Wolda (AMNH).—Ft. Gulich: one male, one female, VI-5-1976, at lights, col. D. Engleman (AMNH); one female, I-26-1976, coll. H. D. Engleman, Al Thurman col. (AMNH); one male, V-4-1977, D. Engleman (AMNH); 2 males, IV-22-1976, lights, Al Thurman (AMNH); one male, III-18-1977 lights, coll Al Thurman (AMNH).

Adevoplitus casei (Thomas, 1980), NEW COMBINATION
(Figs. 4–6, 17, 24–26, 35)

Pseudevoplitus casei Thomas, 1980:293–296; Brailovsky & Barrera, 1982:234–236.

Male genitalia (Figs. 4–6). General outline of pygophore in posterior view as biconvex lens, postero-lateral angles protruding in midpoint position; medial excavation of ventral rim very broad, open "V" (Fig. 17). Apex of *processus phallothecae* 2 truncate, dorsal surface flattish, basal surface convex. In lateral view, dorsal wall of *phallotheca* forming right angle with *processus phallothecae* 2, bearing two evenly spaced verrucae (Fig. 24–26).

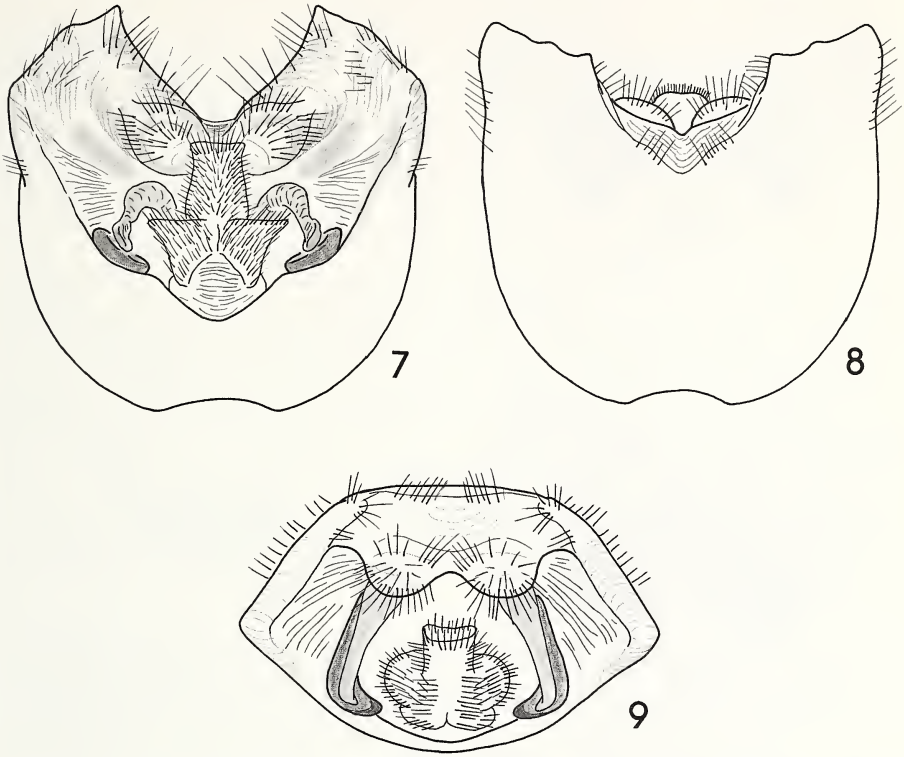
Female genitalia (Fig. 35). Gonocoxites 8 rectangularly elongate so that postero-mesial angles obscure gonocoxites 9; free marginal areas rugulose, borders crenulate, lateral 1/5 shallowly excavate longitudinally; mesial borders contiguous along their length except for postero-mesial angles; posterior borders narrow, slightly obliquely truncate. Posterior border of laterotergites 8 each not produced into lateral spine or lobe, spiracles inconspicuous but visible. Apices of laterotergites 9 barely surpassing transverse band uniting laterotergites 8 dorsally.

Distribution. Mexico (Chiapas), Guatemala (Jutiapa), El Salvador (San Salvador).

Types. Holotype male deposited in NMNH was examined, labeled: (a) GUATEMALA, Jutiapa, Canon de Monjoy CA 1, 27 July 1979, EP Case & DB Thomas (b) HOLOTYPE *Pseudevoplitus casei.*

Paratypes: one male, one female with same data as holotype, deposited in NMNH, were examined.

Additional material: one male, EL SALVADOR, San Salvador, La Libertad, III-19-1972, n. 825, Leg. S. & L. Steinhauser, FSCA (DBT).



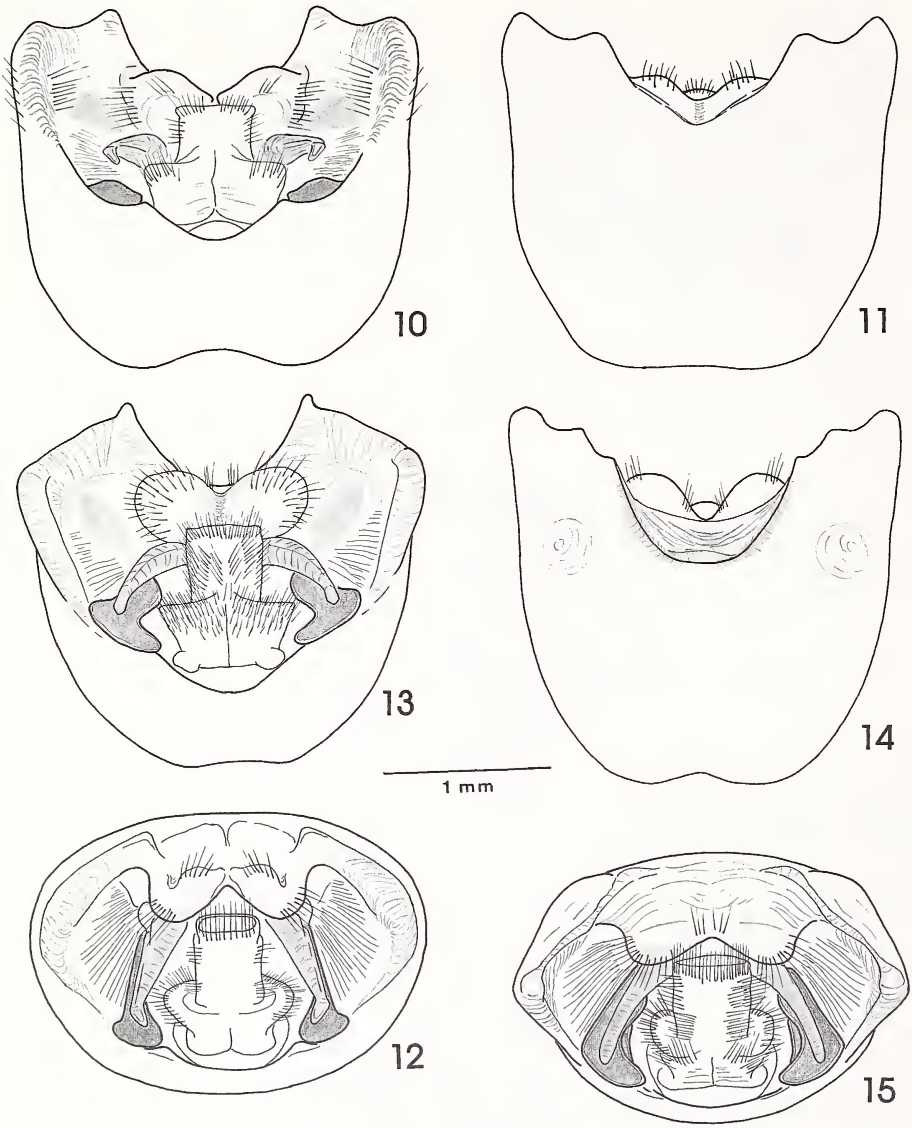
Figs. 7–9. Male genitalia. 7–9. Pygophore in dorsal, ventral, and posterior view, respectively of *Adevoplitus mexicanus.*

Adevoplitus mexicanus (Brailovsky and Barrera, 1982), NEW COMBINATION
(Figs. 7–9, 18, 27–29, 36, 37)

Pseudevoplitus mexicanus Brailovsky and Barrera, 1982:232–234; Brailovsky, 1988: 131–132.

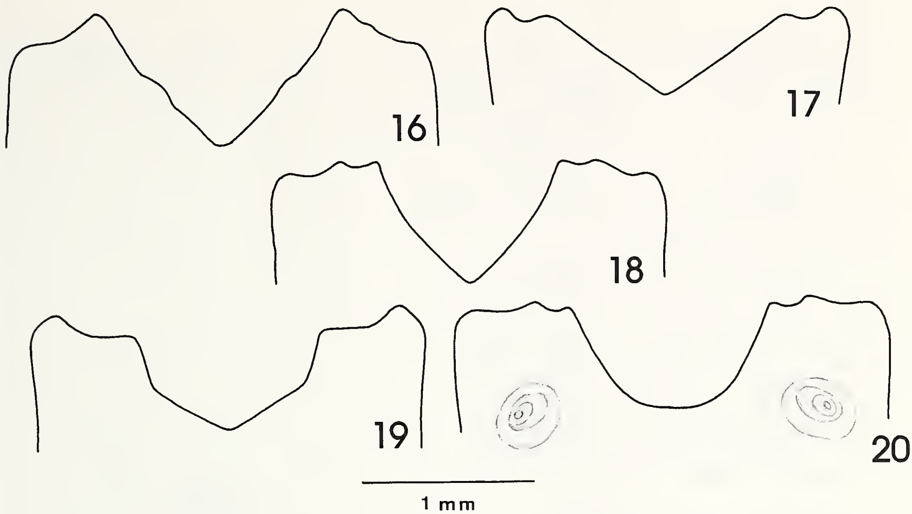
Male genitalia (Figs. 7–9). General outline of pygophore in posterior view with dorsal half convex, ventral half trapezoidal, three sides of trapezoid approximately equal.; breast-like projections of infolding of ventral rim apposed, parallel to each other; medial excavation of ventral rim evenly open V-shaped. (Fig. 18). Apex of *processus phallothecae* 2 obliquely truncate in lateral view, foremost apical one. In lateral view, dorsal wall of *phallotheca* forming obtuse angle with *processus phallothecae* 2, bearing single basal angulation (Figs. 27–29).

Female genitalia (Figs. 36, 37). Gonocoxites 8 nearly ⅓ longer than wide; mesial borders contiguous along ¾ of their length, distal fourth feebly divergent, forming narrow V-shaped notch; posterior border decidedly oblique, feebly sinuate, forming triangle with each lateral border; each lateral angle acute, reaching posterior margin of transverse band uniting laterotergites 8 dorsally, resting in narrow space between



Figs. 10–15. Male genitalia. Pygophore in dorsal, ventral, and posterior view, respectively. 10–12. *Adevoplitus costaricensis.* 13–15. *A. venezolanus.*

laterotergites 8 and 9; lateral marginal areas of gonocoxites 8 laminarly explanate and reflexed; mesial marginal areas and posterior margins somewhat rugulose. Basal parts of laterotergites 8 very deeply sunk forming gap in triangular area where posterior border of sternite VII and each gonocoxite 8 meet; spiracles minute, not visible in resting position. Visible part of gonocoxites 9 bilaterally tumid, posterior border almost rectilinear.



Figs. 16–20. Male genitalia. 16–20. Outline of excavation of ventral rim of pygophore. 16. *A. longicornis.* 17. *A. casei.* 18. *A. mexicanus.* 19. *A. costaricensis.* 20. *A. venezolanus.*

Distribution. Mexico (Veracruz, Chiapas, San Luis Potosi).

Types. Holotype male deposited in UNAM was examined, labeled (a) HOLOTIPO (b) Bonampak, Chiapas, Mexico. 2-V-1978, noct., Harry Brailovsky col. (c) *Pseudevoplitus mexicanus* Brailovsky-Barrera.

Paratype: one male with same data as holotype, deposited in UNAM, was examined.

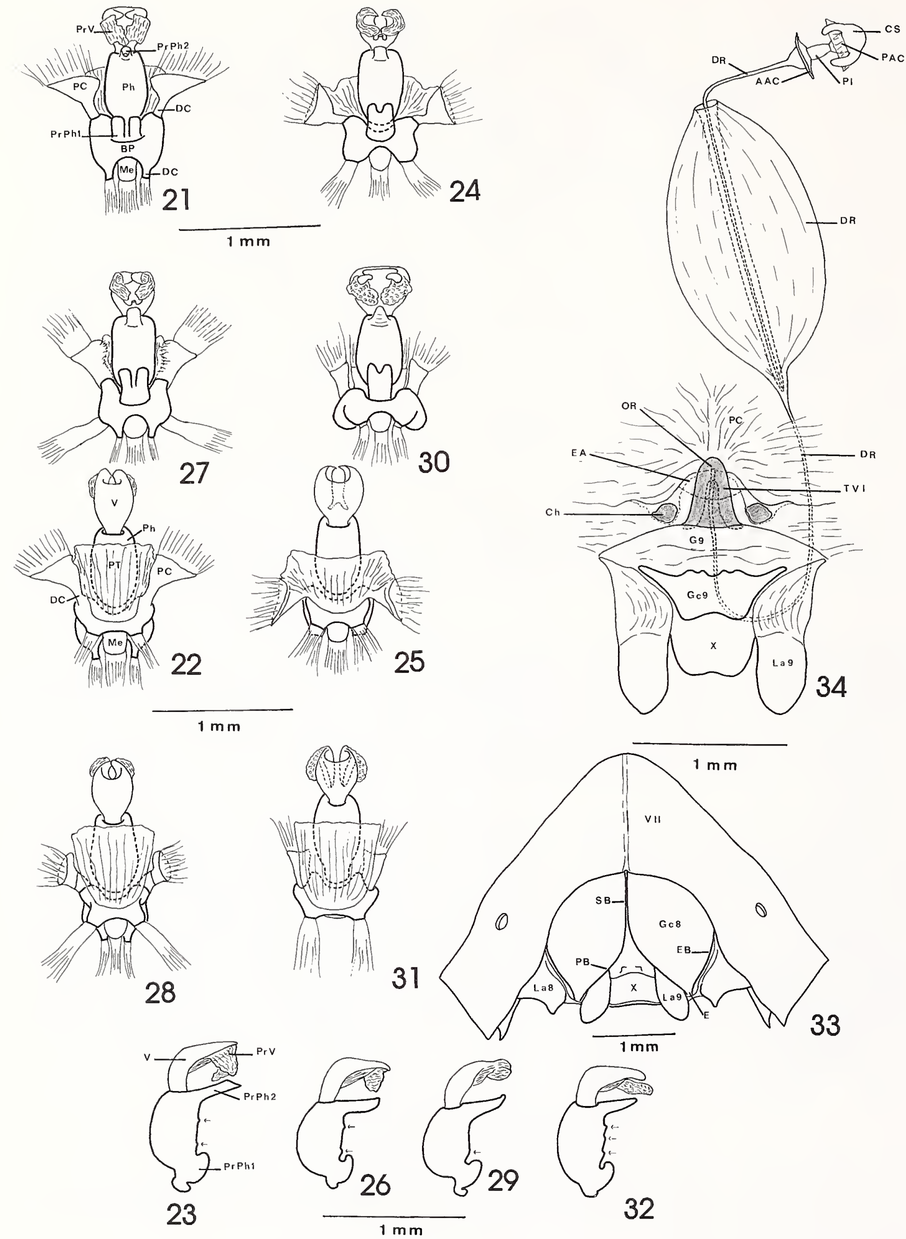
Additional material: MEXICO, Veracruz. Los Tuxtlas: one male, IX-19-1985, L. Cervantes, nocturna, Luz Negra 20:00 a 20:30 (UNAM); one male, IX-14-1985, H. Brailovsky (UNAM); one female, Estacion de Biologia, X-4-1985, C. Mayorga, colecta nocturna 23:00 (UNAM); one male, Estacion de Biologia, X-6-1985, A. Ibarra (AMNH); one male, Estacion de Biologia, IX-30-1985, A. Ibarra (AMNH). Chiapas, Simojovel: one male, VIII-23-1987 (DBT). GUATEMALA: one male, El Progresso, 4rd mi NW Morazan on Hwy. #17 to Salama, IX-17-1961, Hubbell Cantrall Cohn (DAR).

Adevoplitus costaricensis, new species
(Figs. 10–12, 19, 30–32, 38–39)

Description. Elongate ovate, dorso-ventrally depressed with pronotum somewhat gibbous, humeral angles acutely triangular. Dorsal color fulvous or mottled tan, hemelytra reddish-brown.

Male. Measurements. Head length 2.15; width 4.87; length of anteocular part of head 1.00; interocular distance 1.46; interocellar distance 0.5; length of antennal segments: I 1.00, II 2.45, III 3.15, IV 3.46, V 2.46; pronotal length 7.57, width 4.53; scutellal length 5.49, width 4.53; total length 12.56; abdominal width 7.26.

Head fulvous with irregularly distributed reddish-brown punctures. Juga surpass-



Figs. 21–34. Male and female genitalia. 21–32. Male genitalia. *Phallus,* dorsal and ventral views; *phallotheca,* lateral view, respectively. 21–23. *Adevoplitus longicornis.* 24–26. *A. casei.* 27–29. *A. mexicanus.* 30–32. *A. costaricensis.* Figs. 33, 34. Female genitalia. Genital plates and ectodermal genital ducts of *A. longicornis.* (AAC = anterior annular crest, BP = basal plates, Ch = *Chitinellipsen,* CS = *capsula seminalis,* DC = dorsal connectives, DR = *ductus receptaculi,* E = lateral angle of gonocoxites 8, EA = ellipsoidal area of *pars communis,* EB

ing tylus, sometimes contiguous; lateral margins parallel (a few specimens with margins divergent). Rostrum nearly attaining posterior margin of abdominal sternite IV; segment III longest, attaining posterior margin of metasternum. Ocelli large; distance from each ocellus to adjacent eye nearly ⅓ distance between ocelli. Antennal segments II to V dark brown, each with yellowish ring at base and apex; segment I fulvous with brown punctures. Antero-lateral margins of pronotum slightly sinuate; humeri each with minute, lateral, triangular projection. Apex of scutellum nearly acute, sometimes dark brown, attaining imaginary line across postero-lateral angles of hemelytra; scutellar disc with reddish-brown punctures irregularly distributed, patches of dark brown punctures along lateral margins of basal half. Hemelytra densely punctured, darker, especially at basal fourth and posterior half. Legs fulvous, brown maculations on femora and tibiae; segment I of each tarsus fulvous, segments II and III dark brown. Connexival incisures broadly bordered on each side with castaneous or ferrugineous, intervening areas sordid ivory with ferrugineous punctures. Abdominal venter densely punctured with dark brown except longitudinal midline. Seventh sternite, in female, slightly carinate medially; posterior margins of gonocoxites 8 rectangularly excavated.

Genitalia (Figs. 10–12). General outline of pygophore elliptical in posterior view, postero-lateral angles not protruding; medial excavation of ventral rim somewhat angulate, resembling hexagon cut in half (Fig. 19). *Processus phallothecae* 2 narrowing progressively towards tip, apex pointed. In lateral view, dorsal wall of *phallotheca* forming obtuse angle with *processus phallotecae* 2, bearing 3 evenly spaced verrucae (Figs. 30–32).

Female. Measurements. Head length 2.38, width 3.47; length of anteocular part of head 1.17; interocular distance 1.56; interocellar distance 0.67; length of antennal segments: I 1.00, II 2.52, III 3.05, IV 3.73, V 2.63; pronotal length 3.56, width 8.53; scutellal length 6.55, width 5.14; total length 14.59; abdominal width 8.53.

Genitalia. (Figs. 38, 39). Gonocoxites 8 more than ¼ longer than wide; disc slightly tumescent, lateral 1/5 shallowly excavated longitudinally; mesial borders contiguous except for postero-mesial angles; posterior borders strongly, obliquely truncate, each forming triangular outline together with lateral border; lateral angles of gonocoxites 8 not attaining posterior margin of transverse band uniting laterotergites 8 dorsally; crenulation of posterior borders rather obvious. Mesial borders of laterotergites 8 incrassate, reflexed; posterior borders triangularly produced; spiracles minute, not perceptible in resting position. Visible part of gonocoxites 9 bilaterally tumescent; posterior border slightly concave.

Types. Holotype: male, labeled: (a) COSTA RICA, Limon Province, Hdas. La Suer-

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= lateral border of gonocoxites 8, G9 = gonapophysis 9, Gc8 = gonocoxites 8, Gc9 = gonocoxites 9, La8 = laterotergites 8, La9 = laterotergites 9, Me = *membranblase*, OR = *orificium receptaculi*, PAC = posterior annular crest, PB = posterior border of gonocoxites 8, PC = *processus capitati*, PCo = *pars communis*, Ph = *phallotheca*, PI = *pars intermedialis*, PrPhl = *processus phallothecae* 1, PrPh2 = *processus phallothecae* 2, PrV = *processus vesicae*, SB = mesial border of gonocoxites 8, TVI = thickening of vaginal intima, V = vesica, VII = seventh abdominal sternite, X = tenth abdominal segment).

te/Tapezco, 29 air km W Tortuguero, elev. 40 m. lat 10°27′–30′N, long. 83°47′W, VIII-13/31-1979, JP & KE Donahue, CC Hair, NK Moore, MA Hopkins (b) LACM/ Earthwatch, Tapezco's Rainforest Expedition. Deposited in LACM.

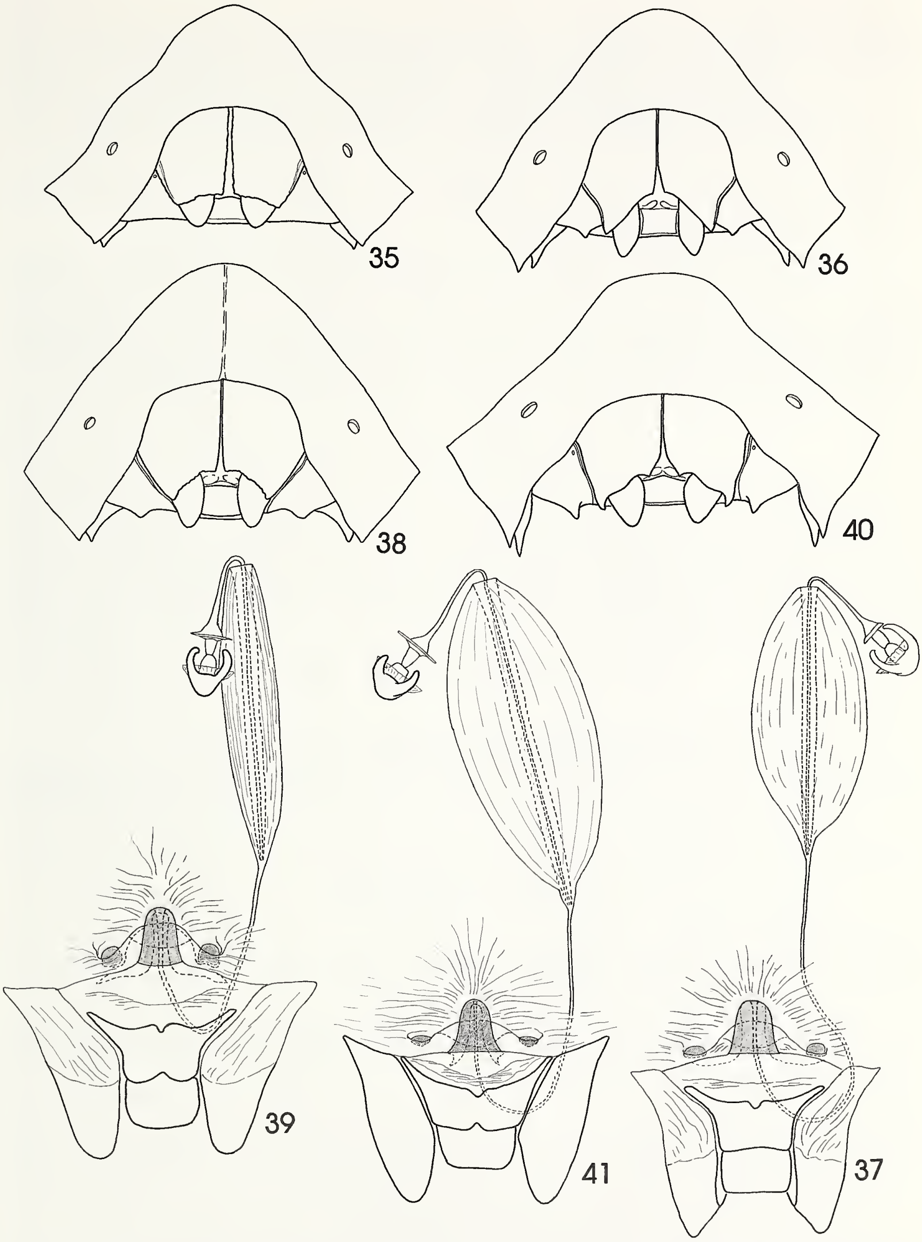
Paratypes: 24 males, 10 females labeled as holotype. Paratypes deposited at the following collections: 5 males, 2 females (AMNH); 5 males, 2 females (DBT); 2 males, 1 female (DZRS); 5 males, 2 females (LACM); 2 males, 1 female (MCNZ); 5 males, 2 females (NMNH).

Adevoplitus venezolanus, new species
(Figs. 13–15, 20, 40, 41)

Pseudevoplitus longicornis, Becker & Grazia-Vieira, 1971: 19, *nec* Ruckes, 1959.

Description. Elongate ovate, dorso-ventrally depressed, pronotum somewhat gibbous, humeri acutely triangular. Dorsal color fulvous, head and hemelytra orange.
Male. Measurements. Head length 2.4, width 3.16; length of anteocular part of head 1.16; interocular distance 1.6; interocellar 0.68; length of antennal segments: I 1.04, II 2.48, III 2.92, IV 3.52, V 2.36; pronotal length 3.44, width 7.46; scutellal length 5.24, width 4.59; total length 13.44; abdominal width 7.29.

Head with few and irregularly distributed reddish-brown punctures. Juga surpassing tylus but not contiguous; lateral margins divergent. Rostrum almost attaining posterior margin of abdominal sternite IV; segment III longest, reaching posterior margin of metasternum. Ocelli large, distance from each ocellus to adjacent eye ⅓ distance between ocelli spaces. Antennal segments II to V dark brown, each with yellowish ring at base and apex; segment I fulvous with brown punctures. Antero-lateral margins of pronotum nearly straight; humeri with minute, extrorse triangular spine. Apex of scutellum acute, pointed, dark brown, attaining imaginary line across postero-lateral angles of hemelytra; disc with reddish-brown punctures irregularly distributed, patches of dark brown punctures along lateral margins of basal half. Hemelytra densely punctured, posterior half with irregular brown spots. Legs fulvous spotted with brown on femora and tibiae; segment I of tarsus fulvous, segments II and III dark brown. Connexival incisures broadly bordered on each side with castaneous or ferrugineous, intervening areas sordid ivory with ferrugineous punctures. Abdominal venter densely punctured with dark brown except mid-longitudinal line.
Genitalia (Figs. 13–15). General outline of pygophore in posterior view with dorsal half convex, ventral half trapezoidal, sides of trapezoid nearly half as long as ventralmost margin; postero-lateral angles protruding in midpoint position; ventral surface provided with roundish, low tumidity each side of evenly U-shaped median excavation of ventral rim. (Fig. 20).
Female. Measurements. Head length 2.43, width 3.21; length of anteocular part of head 1.31; interocular distance 1.45; interocellar distance 0.67; length of antennal segments I 1.00, II 2.07, III 2.68, IV 3.24, V 2.26; pronotal length 3.55, width 8.40; scutellal length 6.21, width 5.09; total length 14.53; abdominal width 8.51.
Genitalia (Figs. 40, 41). Posterior margin of sternite VII shallowly excavated on gonocoxites 8. Gonocoxites 8 nearly ¼ longer than wide, posterior ⅔ flattish; mesial borders contiguous along ¾ of their length, distal fourth divergent, thinly carinate, postero-mesial angle triangularly produced; posterior borders oblique, sinuate. Lateral angles of gonocoxites 8 each provided with hook-like projection reaching or



Figs. 35–41. Female genitalia. Genital plates and ectodermal genital ducts. 35. *Adevoplitus casei.* 36, 37. *A. mexicanus.* 38, 39. *A. costaricensis.* 40, 41. *A. venezolanus.*

surpassing transverse band uniting laterotergites 8 dorsally; lateral margins convexly recurved so that the border lies deep inside genital plates; mesial marginal areas, and particularly posterior marginal areas rugulose. Posterior border of laterotergites 8, each projected into lateral acute point; spiracles very small but visible. Visible part of gonocoxites 9 transversely tumescent, posterior border openly V-shaped.

Types. Holotype male, labeled: (a) VENEZUELA. Zulia, Perija, Kasmera, IV-12-1963 (b) M. Gelbez, P. J. Salinas col. (c) Inst. Zool. Agricola, Fac. Agronomia, Univ. Central Venezuela. Deposited in MCNZ.

Paratypes: one female, labeled: (a) VENEZUELA, Caracas, X-6-1991, Mainest 1.M.16.11.92, deposited in AMNH; one female, labeled: (a) VENEZUELA, Lara, Sarare, X-26-1984, RG Danka (b) DA Rider Collection, deposited in DBT; one female, labeled as the last female except XI-11-1984, deposited in DAR; one female, labeled as the last two females except XI-13-1984, deposited in NMNH.

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J. New York Entomol. Soc. 103(4):401–403, 1995

ROLSTONIELLINI, REPLACEMENT NAME PROPOSED FOR COMPASTINI DISTANT, 1902, A TRIBAL NAME BASED ON A GENERIC JUNIOR HOMONYM (HETEROPTERA: PENTATOMIDAE: PENTATOMINAE)

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Abstract.—Rolstoniellini and *Rolstoniellus* are proposed as replacement names for Compastini Distant, 1902 and *Compastes* Stål, 1867, respectively. Genera and species currently placed in Rolstoniellini are listed, including the following new combinations within *Rolstoniellus: Rolstoniellus boutanicus* (Dallas, 1851); *R. exstimulatus* (Distant, 1902); *R. javanicus* (Yang, 1935); *R. malacanicus* (Yang, 1935); *R. minor* (Atkinson, 1888); *R. neoexstimulatus* (Yang, 1935); *R. spinosus* (Distant, 1887); and *R. taurus* (Distant, 1911).

During the preparation of a catalog of the Pentatomidae of the World, several nomenclatural problems have been discovered. These problems are being corrected in several publications in advance of the catalog. This particular problem involves the replacement of a tribal name in the subfamily Pentatominae.

Rolstoniellini, new name

Compastaria Distant, 1902:196; Oshanin, 1906:140; Cachan, 1952:315, 319. [type genus *Compastes* Stål, 1867]
Compastini: Ahmad et al., 1974:19.

Rolstoniellus, new name

Compastes Stål, 1867:519; Stål, 1876:69, 107; Atkinson, 1888:154; Lethierry & Severin, 1893:184; Distant, 1902:196, 200; Kirkaldy, 1909:148; Bergroth, 1925: 161; Hsiao et al., 1977:95, 123. [not *Compastes* Gistel, 1848:X; Orthoptera]

Gistel (1848) proposed the generic name *Compastes* as a replacement name for the preoccupied orthopteroid genus name *Pteropus* Thunberg, 1815, thus predating Stål's usage of *Compastes* as a pentatomid generic name by 19 years. Acceptance of *Rolstoniellus,* the replacement name proposed herein, will result in the following new combinations: *Rolstoniellus boutanicus* (Dallas, 1851); *R. exstimulatus* (Distant, 1902); *R. javanicus* (Yang, 1935); *R. malacanicus* (Yang, 1935); *R. minor* (Atkinson, 1888); *R. neoexstimulatus* (Yang, 1935); *R. spinosus* (Distant, 1887); and *R. taurus* (Distant, 1911).

This case is further complicated by the fact that *Compastes* Stål serves as the type genus for the tribal name Compastini Distant, 1902, a taxonomic category still in use (Cachan, 1952; Ahmad et al., 1974). According to Article 39 of the International Code of Zoological Nomenclature, a family-group name based on a generic name which has been found to be a junior homonym is invalid, and must be replaced by the next available synonym of the family-group name, or if none exist, by a new

replacement name based upon the valid name of the former type genus. No other family-group names are available.

Based on the literature the following is a list of genera and species considered to belong in the tribe Rolstoniellini:

	Distribution
Agathocles Stål, 1876	
dubius Distant, 1921	Laos
limbatus Stål, 1876	India
yunnanensis Zhang & Lin, 1984	China
Amasenus Stål, 1863	
corticalis Stål, 1863	India, Ligor, Malacca
Critheus Stål, 1867	
indicus (Distant, 1900)	Burma, China, India
lineatifrons Stål, 1869	Burma, China, Hainan Island, Tenasserim, Thailand
painei Ghauri, 1963	Borneo
Exithemus Distant, 1902	
assamensis Distant, 1902	China, India
mausonicus Breddin, 1904	China, India
similis Paiva, 1919	India
Homalogonia Jakovlev, 1876	
confusa Kerzhner, 1972	Korea, Manchuria, e. USSR
croceomaculata Chen, 1983	China
grisea Josifov & Kerzhner, 1978	China, Korea
obtusa obtusa (Walker, 1868)	Amuria, China, India, Japan, Korea, Siberia, Tibet, Ussuri, Vietnam
obtusa yunnana Zheng & Liu, 1987	China
Nesocoris Bergroth, 1914	
badius Bergroth, 1914	New Caledonia
Rolstoniellus, new name	
boutanicus (Dallas, 1849)	Burma, China, India
extimulatus (Distant, 1902)	India
javanicus (Yang, 1935)	Java
malacanicus (Yang, 1935)	Bhutan
minor (Atkinson, 1888)	India
neoextimulatus (Yang, 1935)	Bhutan, China
spinosus (Distant, 1887)	India
taurus (Distant, 1911)	India

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A NEW SPECIES OF *SPINALANX* ROLSTON AND RIDER FROM SOUTH AMERICA (HETEROPTERA: PENTATOMIDAE)

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Abstract.—A new species of the South American genus *Spinalanx* is described from southern Brazil. The primary differentiating characters are found in the genitalic structures. The new species is named in honor of the distinguished hemipterist, L. H. Rolston.

Key words: Insecta, Pentatomidae, taxonomy, genitalia.

Among the genera of Western Hemisphere Pentatomini which lack a median spine or tubercle at the base of the abdomen (section 1), six have the surfaces of the femora armed or tuberculate. One of these, the genus *Spinalanx* Rolston and Rider, was erected to hold two South American species: *S. monstrabilis* Rolston and Rider, the type-species, from Peru and Colombia, and *S. corusca* Rolston and Rider, known from a single Bolivian female (Rolston & Rider 1988). In this genus the femoral surfaces have scattered, seta-bearing tubercles. Rolston and Rider (1988) differentiate *Spinalanx* from *Agroecus* Dallas using two key characters: the absence of impunctate bands on the hemelytral corium, and the presence of small tubercles on the basal plates of the female terminalia.

In my collection are five specimens representing an undescribed species from southern Brazil which is assignable to this genus. It agrees in all essential characters found in *Spinalanx* with the exception of the tubercles on the female basal plates. However, other characters align this species with *Spinalanx* rather than *Agroecus.* The low, seta-bearing, femoral tubercles are scattered, rather than in parallel rows, as in *Agroecus.* And, although the female basal plates lack tubercles, neither are they strongly convex, the condition typical of *Agroecus* (Rider and Rolston, 1987).

These unusual specimens were collected by me in southern Brazil in early 1980. Because of their similarity to certain species, which at the time were considered to be members of the genus *Euschistus* Dallas, I sent these to the authority on the latter genus, L. H. Rolston of Louisiana State University. Professor Rolston returned these specimens to me bearing a determination label, "*Agroecus* complex, n. gen. n. sp. LHR 80."

Presumably Rolston had forgotten about these specimens at the time that he and our colleague David A. Rider described the genus *Spinalanx,* or perhaps because of the lack of tubercles on the female plates, his notes did not reflect the true relationship of the species. In fact it is only recently upon concerted study of the specimens that I realized that they belonged to their genus. I now take the opportunity of the occasion of this issue dedicated to my long time friend, Larry Rolston, to describe this species in his honor.

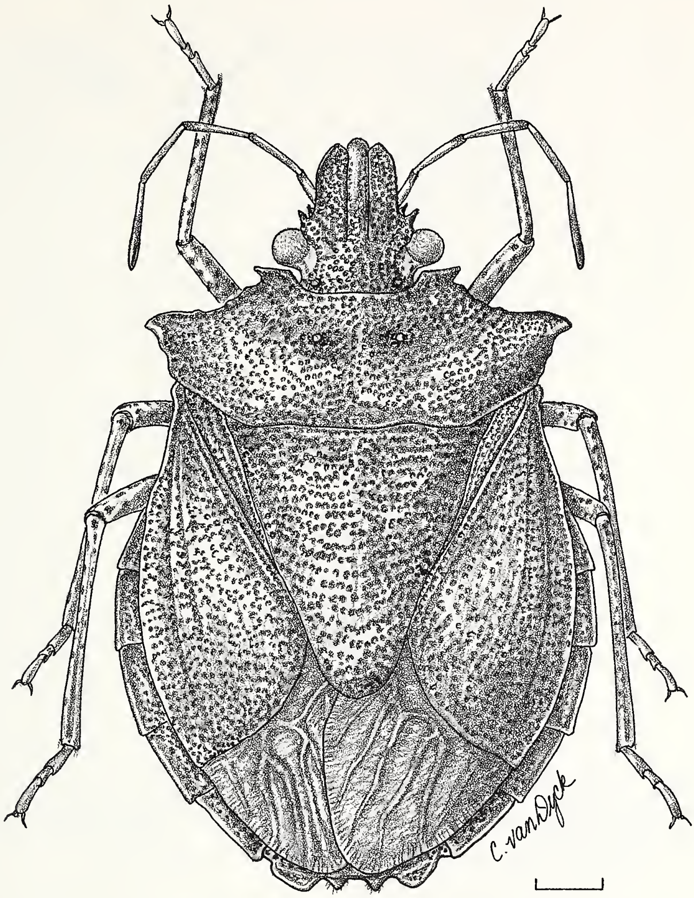


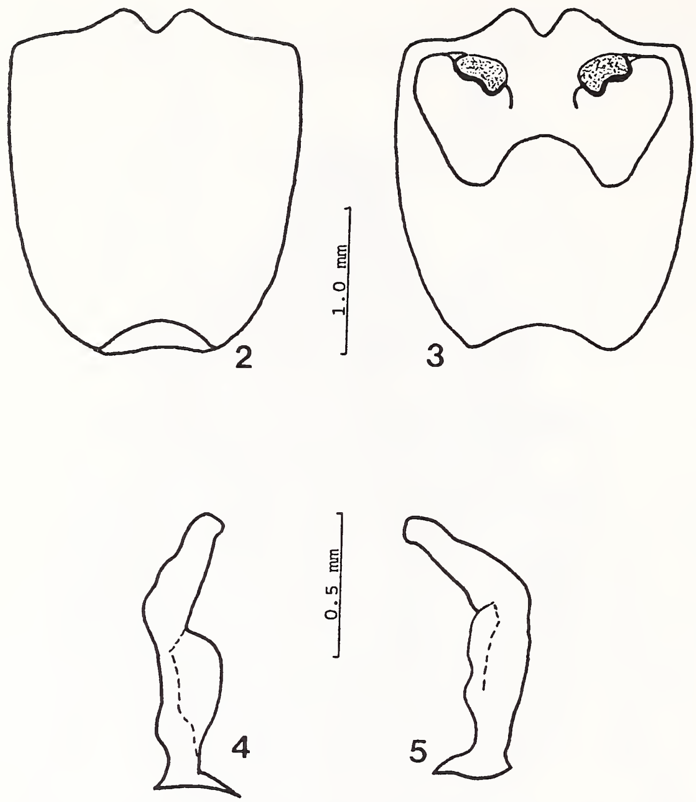
Fig. 1. Dorsal habitus of *Spinalanx rolstoni,* new species (bar = 1.0 mm).

Spinalanx rolstoni, new species
(Figs. 1–7)

Description. Dorsum dark brown; closely, darkly punctate; interstitial surfaces rugulose, strongly so near anterolateral pronotal margins. Venter tan with dense dark punctation; margins narrowly yellowish-tan on connexivum and basal reflexion of exocorium; broadly yellowish-tan at and behind humeral angles. Length 10.5 mm, width 6 mm.

Head. Tylus separated from apices of juga by a deeply notched incision. Lateral margins of juga sinuate; anteapical angles projecting acutely. Ocelli separated from eyes by about two and a half times their width. Each antennal segment I to V slightly longer than preceding segment; segment V about one-third longer than I. Rostrum attaining base of abdomen in repose.

Thorax. Anterior angle of humeri produced bluntly, similar to the humeri of *S.*

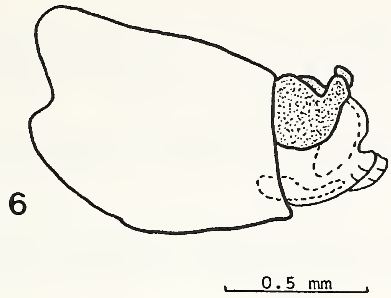


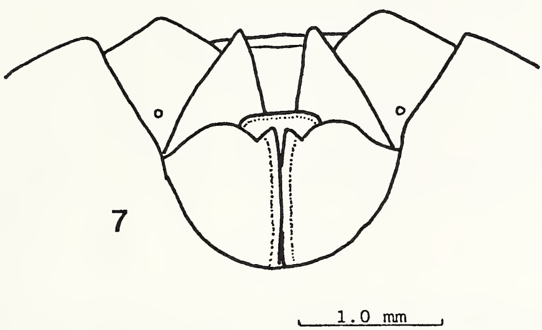
Figs. 2–5. Male genitalia of *Spinalanx rolstoni:* 2. pygophore, ventral view; 3. pygophore, dorsal view. 4. right paramere, ental view; 5. right paramere, ectal view.

corusca. Anterolateral margins carinately rugulose, the apices of rugae bearing short stiff setae. Anterior angle projecting as a short, stout, subterete spine. Dorsal surface of pronotum bearing a pair of small, dull yellow tubercles, one at inner angle of each cicatrice. Basal angles of scutellum each with shallow black pit; surface irregularly rugulose; apex darkened. Lateral margin of corium evenly arcuate; posterior margin strongly curved; yellow impunctate spot on disc of corium at terminus of exocorial suture. Membrane shortened, subtriangular in outline, not quite extending to abdominal apex. Femora with many low, dark, seta-bearing tubercles; these scattered, not in rows. Tibia prismatic with planar surface sulcate, at least proximally. Evaporatorium reduced to about one-fifth the surface of the metapleuron. Orifice with minute angulate auricle.

Abdomen. Venter evenly convex. Connexiva broadly exposed and bearing fringe of minute setae. Each sternite with pair of close set trichobothria on each side; the mesial member of each pair situated on imaginary line joining each spiracle.

Genitalia. Male. Pygophore bisinuately emarginate in ventral and dorsal view (Figs. 2, 3). Lumen of pygophore bearing pair of thickened cusps, one on each side





Figs. 6, 7. Genital structures of *Spinalanx rolstoni:* 6. Male aedeagus, lateral view. 7. Female valvulae, ventral view.

just ental to posteroventral margin (Fig. 3). Head of each paramere subacuminate, irregularly terete; shaft with thin alate flange (Figs. 4, 5). Thecal appendages thickened, sclerotized (Fig. 6). Female. Basal plates without tubercles; posterior margins sinuously arcuate in ventral view until abrupt angulation at mesial occlusion. Inframargin of mesial edge impressed. Ninth paratergites triangular in outline. Eighth paratergites with spiracle present (Fig. 7).

Types. Holotype: Male, labeled (a) BRAZIL, Sta. Catarina, 15 mi W. Ponte Serrada. 1 MAR 1980, D. B. Thomas Coll. Deposited in American Museum Natural History, New York. Paratypes: 3 females same data. 1 male, labeled (a) BRAZIL, Paraná, 5 mi S. Guaraniaçu, 26 FEB 1980, D. B. Thomas Collector. Deposited American Museum Natural History (1 female), collection of author (1 male, 2 females).

ACKNOWLEDGMENTS

The relationship of these specimens to the genus *Agroecus* was determined by Professor L. H. Rolston. I am deeply indebted to Larry Rolston for years of encouragement, inspiration, and general good will. The habitus drawing of *S. rolstoni* was rendered by Chris Mari Van Dyck.

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THE SYSTEMATIC POSITION OF THE GENUS *TAHITOCORIS* (HEMIPTERA: PENTATOMIDAE: PODOPINAE)

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Abstract.—New data are presented concerning the morphology of the monobasic genus *Tahitocoris,* especially its female genitalia and the distribution of its abdominal trichobothria. It is concluded that the subfamily Tahitocorinae should fall as a synonym of Podopinae.

The pentatomid subfamily Tahitocorinae, genus *Tahitocoris* (monobasic; type-species: *Tahitocoris cheesmanae* Yang) and species *Tahitocoris cheesmanae* were all founded by Yang (1935). The highly modified body form associated with extreme brachyptery is an obvious autapomorphy of no help in understanding its relationships. Advances in the past 60 years in the understanding of the structure of the female genitalia of Pentatomoidea and of the significance of the patterns of distribution of their abdominal trichobothria mean that a re-examination of Yang's original material can yield further information of value in determining the relationships of this enigmatic genus.

OBSERVATIONS

Material examined: holotype and paratype, both female, of *Tahitocoris cheesmanae* Yang, 1935, in the collection of the British Museum (Natural History), London. Both damaged, paratype lacking head.

Description. Small, brown, brachypterous; abdomen almost circular in outline. Body very strongly punctured (abdomen less strongly so), glabrous.

Head. Eyes strongly stylate, head in front of eyes smoothly rounded, antennifers visible in dorsal view. Ocelli absent. Tylus parallel-sided throughout; juga as long as tylus, plate-like, flat above. Bucculae short, posteriorly convergent and almost meeting at about level of antennifers. Labrum lost. Labial segment 1 stout, reaching to level of anterior border of eyes, segment 2 reaching to level of posterior margin of anterior coxa, segments 3 and 4 lost but apex of rostrum probably reaches base of abdomen as this has a median furrow. Antennae lost.

Thorax. Pronotum with lateral margins irregularly serrate, posterolateral angles each with a short, triangular tooth. Scutellum broad, apically truncate, reaching to suture between abdominal terga 2 and 3. Hemelytra wholly coriaceus, as long as scutellum, posterolateral angles abruptly sinuate. Metasternum with scent-gland orifice dorsad of coxa, well separated from anterior margin of pleuron, completely lacking raised auricle or depressed groove, surrounded by a dull area ("evaporatorium") which does not extend to margins of pleurite. Prosternum, mesosternum and metasternum all shallowly sulcate in midline, not keeled. Coxae short, each placed about its own diameter distant from its neighbours; rest of legs missing in both specimens examined except for mesothoracic leg (minus tarsus) of paratype, with femur mutic and tibia cylindrical but dorsally flattened in its apical one-sixth.

Abdomen. Abdominal tergum with laterotergites 2–7 differentiated; tergum 8 forming apical margin of abdomen in dorsal view; terga 3–7 fused together. Rudiments of scent-glands at posterior margin of tergum 3 small, widely separated, with small sacs; single, broad scar at posterior margin of tergum 4 and another at posterior margin of tergum 5. Sterna 3, 4 and base of 5 with continuous, shallow, median sulcus. Spiracle 2 slightly more mesially positioned than 3–7, just concealed by metapleuron. Trichobothria positioned posterior to spiracles and distinctly mesad of spiracular line, single except for a rudimentary second trichobothrium on one side of segment 5 of paratype.

Genitalia of female (male unknown). Laterotergites 8 joined by narrow bridge, spiracles 8 occluded. Triangulum large. No trace of valvulae or rami. Tergum 9 a narrow, transverse strip, tergum 10 a broader transverse strip, weakly sclerotized; sternum 10 relatively large, well sclerotized, perhaps with sclerotized additions to its anterior margin. Dorsal wall of gynatrium with two small, sclerotized knobs and a complete sclerite around aperture of spermathecal duct. Spermathecal bulb globular, adjacent to proximal pump flange; duct near distal pump flange dilated, with hollow, sclerotized rod running throughout dilation.

AFFINITIES

The body form of this insect is so highly modified that it could be derived from almost any macropterous pentatomoid type. In brachypterous pentatomoids whose macropterous morphs or near relatives have a triangular scutellum, the scutellum remains apically acute. The broadly truncate scutellum of *Tahitocoris* is almost certainly derived from a scutellerid- or podopine-like rounded scutellum. Gross (1975–1976) recognizes several such groups in his Australasian-centred account of pentatomoid diversity. The form of the spermatheca and the presence of a triangulum, with loss of distinct rami and valvulae, clearly place *Tahitocoris* in the family Pentatomidae *sensu stricto.* The enlarged first segment of the rostrum and posteriorly convergent bucculae might suggest a relationship with Asopinae but the stylate eyes are strongly suggestive of Podopinae (*Podops* group of Gross, 1975, 1976). This latter placement is further supported by the sombre coloration and the single trichobothria, found in several genera of tribe Podopini but not tribe Graphosomatini (Schaefer, 1981). It is concluded that Tahitocorinae should fall as a synonym of Podopinae and Podopini NEW SYNONYMY.

NOTE

Usinger (1940:314) stated "further specimens [of *Tahitocoris*] have been collected by Zimmermann in Tahiti, and a single specimen . . . from Borabora." He states further that "a fully macropterous Pentatomoid . . . from Ponape in the Caroline Is . . . may be . . . of this . . . group." This last-mentioned insect is, in fact, *Ponapea arachnoides* Ruckes. (See Ruckes, 1963:326–328.) Attempts to trace Zimmermann's specimens have not been successful.

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GENERIC PLACEMENT AND SYNONYMY OF SOME NEW WORLD SCUTELLERIDAE (HEMIPTERA: HETEROPTERA) IN THE BRITISH MUSEUM (NATURAL HISTORY)

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Abstract.—The type specimens representing most of the New World species of Scutelleridae proposed by Dallas, Distant, Walker, and Westwood were examined for generic placement. A list of correctly placed species and a list of species currently considered junior synonyms are given. New combinations and synonymy are proposed when appropriate. The following new combinations are proposed: *Acantholomidea porosa* (Germar) from *Camirus; Camirus divergens* (Walker) from *Chelysoma*; *Coptochilus neotropicalis* (Distant) from *Chelyschema*; *Diolcus cassidoides* (Walker) from *Ascanius*; and *Testrina wolfii* (Fabricius) from *Chelyschema.* The following new synonymy is recognized: *Chelysomidea* Lattin junior synonym of *Orsilochides* Kirkaldy; *Chelyschema vittata* (Walker), junior synonym of *Chelyschema trinotata* (Walker); *Chelysoma bajulans* (Distant), junior synonym of *Dystus puberulus* Stål; *Chelysoma diversa* (Distant), junior synonym of *Orsilochides scurrilis* (Stål); *Testrina laticollis* Walker, junior synonym of *Testrina wolfii* (Fabricius); *Homaemus fumeus* Distant and *Homaemus retostus* Distant, junior synonyms of *Homaemus proteus* Stål; *Symphylus amazonicus* Kirkaldy, junior synonym of *Symphylus devexus* Walker. Lectotypes and paralectotypes are designated for *Symphylus vittatus* Walker and *Homaemus fumeus* Distant. Lectotypes are designated for *Augocoris gigas* Westwood and *Camirus pullatus* Distant.

Schouteden (1904) provided keys to the genera of Scutelleridae and listed species included in each genus. Distant (1899) made some changes in the generic placement and synonymy of this family, primarily of species described by Walker (1867–1868). Since that time, New World taxa of this family have received little attention with a few exceptions (Eger, 1987, 1990; Lattin, 1964, 1977, 1988; Paleari, 1992). We have examined type material for numerous species, primarily in the British Museum of Natural History, and realized that the generic placement and synonymy of a number of these species needed clarification. The purpose of this paper is to indicate the correct generic placement of New World Scutelleridae described primarily by British authors (Dallas, Distant, Walker, and Westwood) and make necessary changes. In addition, changes in synonymy are made where appropriate at this time.

The format of this paper follows that of Rolston (1976). Names proposed by the above British authors that have been placed, either originally or subsequently, in the correct genus are listed. Names proposed by these authors that are currently considered junior synonyms are listed along with the senior synonym. Following these lists, new combinations and synonymy are proposed and discussed. Although most of the specimens studied were labeled as type or paratype, holotypes and paratypes

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were not designated by these authors. Thus, lectotypes and paralectotypes are designated where appropriate. Label information, as it appears on the label, is given for type specimens examined only in conjunction with changes in synonymy or generic placement. When multiple labels are present, the position of the label is indicated by letters (a), (b), etc., with (a) indicating the uppermost label.

It is a pleasure to dedicate this work to Larry Rolston in recognition of his many contributions to the systematics of the Pentatomoidea and to the science of entomology. It is also fitting that one of his earlier papers served as a model for this one.

VALID SPECIES CORRECTLY PLACED TO GENUS

Agonosoma bicolor Westwood, 1837
Augocoris nigripennis Dallas, 1851
Augocoris rufus Dallas, 1851
Camirus brevilinea (Walker, 1867)
Chelycoris scitulus (Walker, 1867)
Chelycoris vittatus Distant, 1911
Chelyschema leucotela (Walker, 1867)
Crathis ansata (Distant, 1889)
Galeacius crowleyi Distant, 1911
Galeacius tessellatus Distant, 1889
Lobothyreus lobatus (Westwood, 1837)
Orsilochides variabilis marginella (Dallas, 1851)
Orsilochides stictica (Dallas, 1851)
Pachycoris chrysomelinus Walker, 1867
Pachycoris torridus linnaei Westwood, 1837
Polytes bicolor Distant, 1911
Polytes granulatus (Walker, 1868)
Polytes leopardinus Distant, 1911
Polytes lineolatus (Dallas, 1851)
Polytes obscurus (Dallas, 1851)
Polytes propinquus (Walker, 1867)
Polytes rubromaculatus Distant, 1911
Polytes velutinus (Dallas, 1851)
Sphyrocoris elongatus Distant, 1880[2]
Symphylus albomaculatus Distant, 1889
Symphylus deplanatus bipustulatus Walker, 1868
Symphylus leucospilus (Walker, 1867)
Symphylus modestus Distant, 1880
Symphylus obtusus Dallas, 1851
Symphylus cyphonoides (Walker, 1867)
Symphylus deplanatus apicifer Walker, 1868
Symphylus poecilus Dallas, 1851
Symphylus ramivitta Walker, 1868
Symphylus rivulosus (Walker, 1867)
Symphylus signoreti Distant, 1880

SPECIES CURRENTLY CONSIDERED JUNIOR SYNONYMS[3]

Agonosoma flavipes Dallas, 1851 = *Agonosoma trilineatum* (Fabricius, 1781) [Paleari, 1992].
Lobothyreus obscurus Distant, 1880 = *Crathis longifrons* Stål, 1861 [Bergroth, 1891]
Pachycoris apicalis Walker, 1867 = *Lobothyreus lobatus* (Westwood, 1837) [Distant, 1899]

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[2] Types for this species were not located in the British Museum, but material determined as this species by Distant was studied.

[3] In this list, the junior synonym is listed first, followed by the senior synonym and the literature citation where this synonymy was first proposed.

Pachycoris castaneus Dallas, 1851 = *Coptochilus ferrugineus* Amyot & Serville, 1843 [Stål, 1870]
Pachycoris delineatus Walker, 1867 = *Sphyrocoris obliquus* (Germar, 1839) [Distant, 1899]
Pachycoris flavescens Westwood, 1837 = *Diolcus irroratus* (Fabricius, 1775) [Stål, 1870]
Pachycoris guttipes Walker, 1867 = *Tetyra pinguis* (Germar, 1839) [Schouteden, 1904]
Pachycoris nitens Westwood, 1837 = *Pachycoris fabricii* (Linnaeus, 1771) [Stål, 1870]
Pachycoris piperitia Westwood, 1837 = *Ascanius hirtipes* (Herrich-Schaeffer, 1836) [Germar, 1839]
Pachycoris pumila Westwood, 1837 = *Pachycoris fabricii* (Linnaeus, 1771) [Stål, 1870]
Pachycoris quadristriga Walker, 1867 = *Augocoris rugulosus* (Herrich-Schaeffer, 1838) [Distant, 1899]
Polytes inca Distant, 1899 = *Polytes lineolatus* (Dallas, 1851) [Lattin, 1977].
Symphylus gibbosus Distant, 1880 = *Symphylus obtusus* Dallas, 1851 [Distant, 1899]
Symphylus oculatus Walker, 1868 = *Camirus conicus* (Germar, 1839) [Distant, 1899]
Symphylus plagiatus Walker, 1867 = *Symphylus rivulosus* (Walker, 1867) [Distant, 1899]
Symphylus politus Walker, 1868 = *Nesogenes boscii* (Fabricius, 1798) [Distant, 1899]
Symphylus signatus Walker, 1868 = *Lobothyreus lobatus* (Westwood, 1837) [Distant, 1899]
Symphylus vernus Distant, 1889 = *Symphylus cyphonoides* (Walker, 1867) [Distant, 1899]

NEW COMBINATIONS AND NEW SYNONYMY

Acantholomidea porosa (Germar, 1839), NEW COMBINATION

Pachycoris porosus Germar, 1839, pp. 108–109.
Zophoessa porosa; Dallas, 1851, p. 43, pl. 1, fig. 7.
Zophoessa consocia Uhler, 1876, p. 274.
Camirus porosus; Uhler, 1886, p. 2.
Camirus consocius; Uhler, 1886, p. 2.
Camirus pullatus Distant, 1889, p. 316, pl. 30, fig. 9.
Acantholomidea porosa; Lattin, 1964, pp. 69–76, pl. 2, figs. 10–13; McDonald, 1966, p. 16, 49, figs. 73–78, 433–435; McPherson, 1980, p. 1.

Lattin (1964) correctly placed *Pachycoris porosus* in the genus *Acantholomidea*. McDonald (1966) and McPherson (1980) followed Lattin in this placement but other authors, including Froeschner (1988), did not recognize this placement because Lattin's work was not published. *Acantholomidea porosa* closely resembles *A. denticulata* (Stål, 1870), differing primarily in the lack of dentate anterolateral pronotal margins. *Acantholomidea* and *Camirus* have historically been separated by the presence or absence of these dentate margins, but this character is clearly of value only

for separating the two species of *Acantholomidea. Acantholomidea* differs from *Camirus* in having the head more declivent and the bucculae somewhat triangular in shape and more produced ventrally. The bucculae in *Camirus* are more evenly rounded and less produced. In addition, species of *Acantholomidea* are smaller than most species of *Camirus* and are generally black with a few lighter markings. Species of *Camirus* are usually a mottled brown color.

Camirus pullatus was synonymized with *C. porosus* by Schouteden (1904), a decision with which we concur. Distant listed two specimens, one from San Geronimo, Guatemala and one from Bogota, Colombia. Only the Guatemalan specimen, a male, was located. This specimen is designated LECTOTYPE and is labeled: (a) Type. (b) S. Geronimo, 3,000 ft, Champion. (c) *Camirus pullatus* Dist. (d) Brit. Mus. 1893-141. (e) B. C. A., Hem. 1, *Camirus pullatus.* (f) BRIT. MUS. TYPE No. HEM. 522.

***Augocoris gomesii* Burmeister, 1835.**

Augocoris gomesii Burmeister, 1835, Handb. Ent. 2:396.
Augocoris gigas Westwood, 1837, p. 16.

The type series of *Augocoris gigas* consists of two females. Specimen no. 1, designated LECTOTYPE, is labeled: (a) *gigas* Hope. (b) *Augocoris gomesi* Burm. (c) *Scutellera* n. sp. Mexico. (d) TYPE. (e) TYPE HEM.: No. 47 1/2, *AUGOCORIS GIGAS* WESTWOOD, HOPE DEPT. OXFORD. Specimen no. 2 is labeled: (a) 5. (b) Mex. (c) TYPE. WESTW. (HOPE) C. Hemipt. 1837; Part I, page 16, Distant, P. Z. S., 1900, p. 807–825. (d) TYPE HEM.: No. 47 2/2, *Augocoris gigas* Westwood, HOPE DEPT. OXFORD. This species was considered a junior synonym of *A. gomesii* by Germar (1839). Specimen no. 1 is indeed a specimen of *A. gomesii.* The second specimen, however, is *A. ehrenbergii* Germar, 1839. Thus, the type series of *A. gigas* contains one specimen each of *A. gomesii* and *A. ehrenbergii.* The color pattern of the two type specimens is remarkably similar. The lectotype designated here fixes *A. gigas* as a junior synonym of *A. gomesii.*

***Camirus divergens* (Walker, 1868), NEW COMBINATION**

Symphylus divergens Walker, 1868, p. 516.
Orsilochus divergens; Distant, 1899, p. 43.
Chelysoma divergens; Kirkaldy, 1909, p. 283.

The transverse median pronotal impression and declivent head place this species in *Camirus.* The type of *Symphylus divergens* is a female, labeled: (a) Type. (b) 62, 57. (c) *Symphylus divergens.* (d) BRIT. MUS. TYPE No. HEM. 539. No locality is given on the specimen although Walker (1868) gives the locality as "Amazon Region. From Mr. Bates' collection."

***Chelyschema trinotata* (Walker, 1867)**

Pachycoris trinotatus Walker, 1867, p. 51.
Symphylus vittatus Walker, 1867, p. 55. NEW SYNONYMY
Achates ramosus Distant, 1889, p. 311, pl. 30, fig. 4.

Achates trinotatus; Distant, 1899, pp. 42, 50.
Achates vittatus; Distant, 1899, pp. 42, 50.
Chelyschema trinotatus; Schouteden, 1904, p. 47.
Chelyschema vittatus; Schouteden, 1904, p. 47.
Chelyschema trinotata; Kirkaldy, 1909, p. 283.
Chelyschema vittata; Kirkaldy, 1909, p. 283.

The synonymy of *A. ramosus* with *C. trinotata* was established by Distant (1899). The type of *A. ramosus* is merely the male of *C. trinotata* which was described from a single female. The type series of *Symphylus vittatus* consists of two females. The specimen labeled as follows is designated LECTOTYPE: (a) Type. (b) Para. (c) 10. *SYMPHYLUS VITTATUS.* (d) BRIT. MUS. TYPE No. HEM. 549. The PARALECTOTYPE is labeled: (a) Paratype. (b) Amaz. (c) Saunders. 65-13. (d) *Symphylus vittatus*; Walker's catal. These two specimens are nearly identical to, and certainly conspecific with, the type of *Pachycoris trinotatus.* The single female type of *P. trinotatus* is labeled: (a) Type. (b) Bras. Tapayos. (c) a. Tapayos. (d) 35. *PACHYCORIS TRINOTATUS.* (e) BRIT. MUS. TYPE No. HEM. 547. The single male type of *Achates ramosus* is labeled: (a) Type. (b) San. Juan, Vera Paz, Champion. (c) B. C. A. Hem. I. *Achates ramosus.* (d) *Achates ramosus* Dist. (e) BRIT. MUS. TYPE No. HEM. 548. It differs significantly from the types of *Pachycoris trinotatus* and *Symphylus vittatus* only in sex.

***Orsilochides* Kirkaldy, 1909, NEW STATUS**

Orsilochus Stål, 1867, p. 493 (type = *Pachycoris variabilis* Herrich-Schaeffer, 1837; preoccupied by *Orsilochus* Burmeister, 1847, Handb. Ent. 5, p. 112, in the Coleoptera).
Chelysoma Bergroth, 1891, p. 235 (new name for *Orsilochus* Stål; preoccupied by *Chelysoma* Gravenhorst, 1843, Vergl. Zool. p. 63, in the Tunicata).
Chelysoma subgen. *Orsilochides* Kirkaldy, 1909, p. 283 (type = *Orsilochus diversus* Distant, 1889).
Chelysomidea Lattin 1988, p. 689 (unnecessary new name for *Chelysoma* Bergroth, 1891). NEW SYNONYMY

Kirkaldy (1909) proposed *Orsilochides* as a subgenus of *Chelysoma,* naming *Orsilochus diversus* as the type. The name *Chelysoma* was preoccupied, so *Orsilochides,* as the next oldest genus-group name becomes the valid name for the genus. As discussed below, characters on which Distant based *Orsilochus diversus* are artifacts of a callow specimen. Kirkaldy also used these characters as the basis of the subgenus *Orsilochides.* Thus, division of this genus into subgenera was not warranted. Lattin (1988) overlooked Kirkaldy's name and proposed the name *Chelysomidea* as a replacement name for *Chelysoma. Chelysomidea* is, therefore, a junior synonym of *Orsilochides.*

***Orsilochides scurrilis* (Stål, 1855)**

Pachycoris scurrilis Stål, 1855, p. 81.
Orsilochus scurrilis, Stål, 1870, p. 10.
Orsilochus diversus Distant, 1889, p. 312, pl. 30, fig. 12. NEW SYNONYMY

Chelysoma scurrilis; Kirkaldy, 1909, p. 284.
Chelysoma diversa; Kirkaldy, 1909, p. 284.

The single type specimen of *Orsilochus diversus* is a callow male labeled: (a) Type. (b) S. Geronimo, Guatemala. Champion. (c) B.C.A., Hem. 1. *Orsilochus diversus.* (d) *Orsilochus*? *diversus* Dist. (e) BRIT. MUS. TYPE No. HEM. 540. Distant (1889) stated that "The structure of the antennae [fourth and fifth segments deeply sulcate], in connection with the very distinct basal impression to the scutellum, renders this species very distinct from the other members of the genus. . . ." Both of these characters are artifacts resulting from the callow nature of the specimen. The type is badly damaged, but the dorsal coloration of *Orsilochides scurrilis* (chocolate brown with yellow 'zig-zag' fascia) is quite distinct and can be seen in this specimen. Overall size and shape, and characters not distorted in the type leave little doubt that *Orsilochus diversus* is a junior synonym of *Orsilochides scurrilis.*

Coptochilus neotropicalis (Distant, 1899), NEW COMBINATION

Achates neotropicalis Distant, 1899, pp. 42–43.
Chelyschema neotropicalis; Schouteden, 1904, p. 47.

The head of this species is concave, the lateral margins of the juga curving dorsad, placing it with certainty in *Coptochilus.* The type is a male, labeled: (a) Type. (b) Madeira R., Amazon. (c) Distant Coll., 1911-383. (d) *neotropicalis* Distant. (e) BRIT. MUS. TYPE. No. HEM. 557.

Diolcus cassidoides (Walker, 1867), NEW COMBINATION

Pachycoris cassidoides Walker, 1867, p. 48.
Tetyra? *cassidoides*; Uhler, 1886, p. 1.
Ascanius cassidoides; Distant, 1899, pp. 42, 50.

The shape of the body and head is similar to that of *Ascanius* spp., but the male and female genitalia clearly place *Pachycoris cassidoides* in *Diolcus.* In *D. cassidoides,* as in other species of *Diolcus,* the dorsal punctation is relatively even and fine and the ostiolar rugae are short, consisting of an enlarged concavity extending laterad a short distance from the ostiole. In species of *Ascanius,* the dorsal punctation is clustered and coarse and the ostiolar rugae are auriculate apically. In addition, the distribution of *D. cassidoides* (Hispaniola) is consistent with that of other species of *Diolcus* (primarily the Caribbean Islands and countries bordering the Caribbean). Species of *Ascanius* are found in central and southern South America. The type of *Pachycoris cassidoides* is a female labeled: (a) Type. (b) 16. *Pachycoris cassidoides.* (c) 66 12. (d) Haiti. (e) BRIT. MUS. TYPE No. HEM. 535.

Dystus puberulus Stål, 1862

Dystus puberulus Stål, 1862, p. 83.
Orsilochus bajulans Distant, 1900, p. 687. *NEW SYNONYMY*
Dystus villosus Breddin, 1904, p. 153.
Chelysoma bajulans; Bergroth, 1908, p. 142.

The densely pubescent, strongly convex body and distinctly flattened antennal

segments place *O. bajulans* in *Dystus.* The type is a male, labeled: (a) Type. (b) San José, 1161 m, 42, P. Biol. (c) Distant Coll., 1911-383. (d) *Orsilochus bajulans* (type) Dist. (e) *bajalans* [sic!] Dist. (f) BRIT. MUS. TYPE No. HEM. 538. An additional label which read: "9. *PACHYCORIS STICTICUS*" undoubtedly was misplaced and belongs on the type of *P. sticticus* Dallas, 1851, which lacked the characteristic name label. The label was placed on the type of *P. sticticus* by JDL.

The type of *O. bajulans* is nearly identical to that of *D. puberulus* examined by JDL in the Naturhistorische Museum Vienna. The type of the latter species, a female, bears the following data: (a) Mexico, Coll. Signoret (b) *puberulus,* det. Stål.

***Homaemus proteus* Stål, 1862**

Homaemus proteus Stål, 1862, p. 82.
Homaemus fumeus Distant, 1889, p. 314, pl. 30, fig. 6. NEW SYNONYMY
Homaemus retostus Distant, 1889, p. 314, pl. 30, fig. 7. NEW SYNONYMY

This is a variable species. Distant's names apply to color variants of *H. proteus.* The type series of *H. fumeus* consists of two females. The LECTOTYPE, designated here, is labeled as follows: (a) Type. (b) Type. (c) Orizaba, H.H.S. & F.D.G., Dec. 1887. (d) B.C.A., Hem. 1, *Homaemus fumeus.* (e) *Homaemus fumeus* Distant. (f) BRIT. MUS. TYPE No. HEM. 505. The PARALECTOTYPE is labeled: (a) Paratype. (b) Omilteme, Guerrero, 8,000 ft, July, H. H. Smith. (c) Distant Coll., 1911-383. (d) *fumeus* Distant. The type of *H. retostus* is a female, labeled: (a) Type. (b) *Homaemus retostus* Dist. (c) Atoyac, Vera Cruz. Schumann. (d) Brit. Mus. 1893-141. (e) B.C.A., Hem. 1, *Homaemus retostus* Dist. (f) BRIT. MUS. TYPE No. HEM 575.

***Symphylus devexus* Walker, 1868**

Symphylus divergens Walker, 1868, p. 517.
Symphylus devexus Walker, 1868, p. 578 (new name for *Symphylus divergens* Walker, 1868).
Symphylus amazonicus Kirkaldy, 1909, p. 370 (unnecessary new name for *Symphylus divergens* Walker, 1868) *NEW SYNONYMY*

Walker (1868) used the name *Symphylus divergens* for two different species described on subsequent pages (516 & 517) of his catalog. However, in the same work (p. 578), he corrected his error by proposing the replacement name *S. devexus* for the species described as *S. divergens* on p. 517. Walker's correction was overlooked by subsequent authors and Kirkaldy (1909) proposed *S. amazonicus* as a replacement name for *S. divergens. Symphylus amazonicus* is thus a junior synonym of *S. devexus.* The type is a male, labeled: (a) Type. (b) Braz; 62, 54. (c) Symphylus divergens. (d) BRIT. MUS. TYPE No. HEM. 518.

***Testrina wolfii* (Fabricius, 1803), NEW COMBINATION**

Tetyra wolfii Fabricius, 1803, p. 134.
Pachycoris wolfii; Germar, 1839, p. 91.
Testrina laticollis Walker, 1867, p. 61. *NEW SYNONYMY*
Achates wolfii; Stål, 1868, p. 13.
Chelyschema wolfii; Schouteden, 1904, p. 47.

This is a distinctive species with strongly convex and slightly explanate anterolateral pronotal margins. It resembles species of *Chelyschema* and *Tetyra* in the size and shape of the body, scutellum and ostiolar rugae, and, to a lesser degree, in the shape and size of the female genital plates. It differs from species of these genera in the more broadly rounded head, lack of distinctly concave lateral jugal margins, more convex dorsum, less convex venter, and more convex anterolateral pronotal margins. These differences may not be sufficient to warrant a separate genus for *T. wolfii,* but in the absence of male specimens for study, placement in either *Tetyra* or *Chelyschema* would be tentative.

The type of *Testrina laticollis* is a female, labeled: (a) Type. (b) Braz. (c) *Testrina laticollis.* (d) BRIT. MUS. TYPE No. HEM. 545. The type of *Tetyra wolfii* is a female in the Universitets Zoologiske Museum, Kobenhavn, and is labeled: (a) Type. (b) Amer. Mer. Schmidt, Mus. S.p. J.L., *wolfii,* Fabr.

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A REVIEW OF THE *PHYLLOPHAGA IGNAVA* SPECIES GROUP WITH DESCRIPTIONS OF TWO NEW SPECIES FROM TEXAS (COLEOPTERA: SCARABAEIDAE; MELOLONTHINAE)

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Abstract.—The composition and characterization of the *ignava* species group of *Phyllophaga* (*s. str.*) are reviewed, and two new species belonging to this group, *P. invisa* and *P. rolstoni,* are described from Texas. Genitalia are illustrated for each new species and enface views of the parameres are given for *P. ignava* (Horn) and *P. idonea* Sanderson, two previously described members of the group. The range, habitat, and flight periods in Texas are presented for each species belonging to the group. A lectotype is designated for *P. ignava.*

This work is the first of a planned series of papers on the species of *Phyllophaga* occurring in Texas in which we will address taxonomic problems, including the descriptions of new species, and present new distributional and biological data. The species group which includes *Phyllophaga ignava* (Horn) as its first-described member is treated here.

Two modern (post-Horn, 1887) concepts have been proposed for the *ignava* species group of *Phyllophaga s. str.* Sanderson (1958) provided a morphological definition for the group in a key to Arizona species groups. His concept was broad and included species which possessed either a fixed or free lower spur on the male hind tibia and diverse forms of the parameres. Morón (1986) restricted the definition by removing three of the species included by Sanderson: *P. fucata* (Horn), *P. lobata* (Fall) and *P. opaca* (Moser). Morón included only two species in the group: *P. ignava* and *P. saylori* Sanderson. The latter was described from Nuevo Leon, Mexico (Sanderson, 1965). Morón's narrower concept for the *ignava* group is followed here; however, the following characters support the removal of *P. saylori* from the *ignava* species group: the short antennal club of the male, the shape of the male abdomen in lateral view, the dorsally asymmetrical parameral base, the narrow and widely divergent parameres, and the heavily sclerotized aedeagus which possesses articulated armature. From study of the original description, we believe *P. saylori* is best placed in the *schizorhina* species group, although the dorsal margin of the parameral base is asymmetrical, not symmetrical as in the other members of that group (Morón, 1986).

Four species are recognized in the *ignava* species group: *P. ignava* (Horn), *P. idonea* Sanderson, and the two new species described herein.

Phyllophaga s. str., group ignava

Diagnosis: Parallel-sided, reddish-brown, dorsally glabrous. Antennae 10-segmented, male club long, about as long as funicle and scape combined; female club short, about as long as funicle. Abdomen with very weakly expressed sexual dimorphism;

moderately swollen in lateral view, slightly more so in female; visible sternum 5 very short, anterior edge impressed to level below posterior margin of sternum 4. Both hind tibial spurs of male free, upper spur long and narrow, nearly as long as or (usually) slightly longer than first hind tarsal segment. All pairs of claws symmetrical, each claw weakly curved with a moderate-sized, submedian tooth; base of claw rounded. Male genitalia symmetrical, parameres elongate-tubiform, with median ventral area membranous. Aedeagus with little sclerotization, inornate; aedeagal apodemes separate proximally, fused more or less by varying degrees of sclerotization along midlength, fused dorsally but not ventrally at apex. Internal sac of aedeagus tubiform, more or less symmetrical, swollen distally with broad band of microspines encircling base of swollen area. Female with weakly sclerotized superior and inferior plates, pubic process absent.

KEY TO SPECIES OF THE *PHYLLOPHAGA IGNAVA* SPECIES GROUP

1. Fringe setae of elytra inconspicuous, hidden from dorsal view; body larger, length 16.6–21.1 mm; parameres with apices narrowly separated enclosing a single ovoid distal opening (Fig. 1) . . . . *invisa* n. sp.
   Fringe setae of elytra conspicuous, those below humeral umbone long and easily seen from dorsal view; parameres variable 2
2. Parameral base with broad proximally-directed lobes below (figs. 7, 9), apices of parameres widely separated not enclosing the distal opening (fig. 4); body smaller, length 13.1–15.7 mm . . . . *rolstoni* n. sp.
   Parameral base unmodified below, apices of parameres narrowly separated enclosing a distal opening; body generally larger, length 14.5 to 18.0 mm 3
3. Distal opening of parameres singular, oval in shape (fig. 2); internal sac without sclerotized armature . . . . *ignava* (Horn)
   Distal opening of parameres doubled, figure eight-shaped (fig. 3); internal sac armed with a large, recurved, tooth-like process . . . . *idonea* Sanderson

Phyllophaga (*s. str.*) *ignava* (Horn)
(Fig. 2)

Lachnosterna ignava Horn, 1887:280.
Phyllophaga ignava: Glasgow, 1916:74.

Some confusion regarding the application of this name was fostered with the publication of the male genitalia photographs by Luginbill and Painter (1953, plate 51, figs. 8, 9; pl. 56, figs. 10, 11). Of these figures, those where the double or figure eight-shaped distal opening of the parameres can be seen (plate 51, fig. 8 and plate 56, figs. 10, 11) are not *P. ignava* but *P. idonea.* This structure of the parameres is unique to *P. idonea* and was illustrated by Sanderson (1948) as part of the original description. Through an apparent oversight, Luginbill and Painter did not treat either *P. idonea* or *P. gaigei* Sanderson which was described in the same paper. The first published illustration of the male genitalia of *P. ignava* is found in Smith (1889, plate 60, fig. 77) and shows a single, round distal opening matching that of the specimen which is here designated as the lectotype (see below).

Range: Regarding *P. ignava,* Luginbill and Painter (1953) state that it is a rare species occuring from Arizona to southwestern Texas. The occurrence of *P. ignava* in Arizona has not been confirmed by us. William Warner and Scott McCleve, who

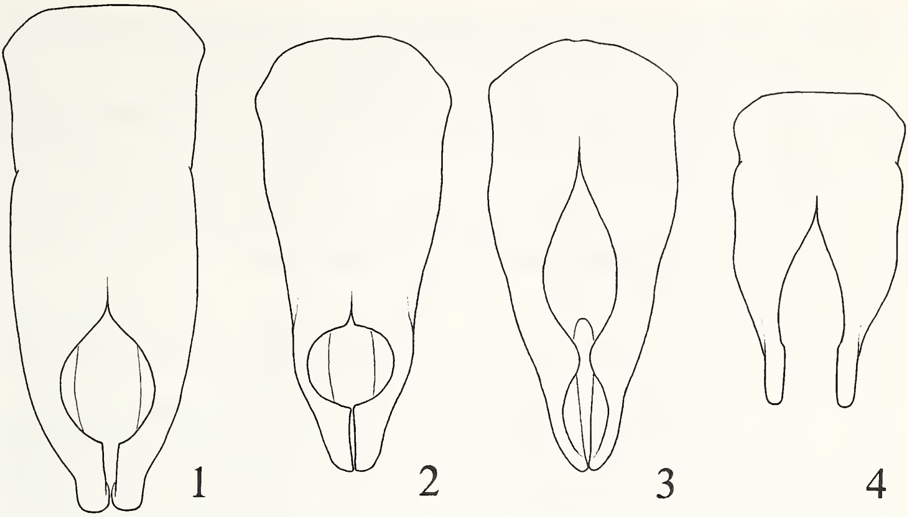


Fig. 1–4. En-face view of parameres of species of the *ignava* group. 1, *P. invisa* n. sp. 2, *P. ignava* (Horn). 3, *P. idonea* Sanderson. 4, *P. rolstoni* n. sp.

have collected extensively in Arizona, have not taken *P. ignava* in that state (personal communications, 1992). In addition, William Warner has examined many specimens from Arizona identified as *P. ignava* in various collections and has found that all are *P. idonea* (personal communication, 1992). All material we have seen from Arizona represents *P. idonea,* and we believe the Arizona records of *P. ignava* in Butler and Werner (1961), the record and larval description in Rosander and Werner (1970), and Sanderson's (1958) reference to *P. ignava* in Arizona, are probably misidentifications of *P. idonea.*

We have found *P. ignava* to be one of the most commonly taken *Phyllophaga* along the southern border of Texas. Its range extends northward to Central Texas. Reinhard (1950) reported it from Johnson County (near Fort Worth, Texas). In addition to material from Texas, we have seen specimens from southeastern New Mexico and the Mexican states of Chihuahua, Coahuila and Durango.

Habitat: In Texas, *P. ignava* occurs in sabal palm groves (Brownsville area), south Texas brushlands, xeric areas and montane oak-juniper and oak-pine-juniper associations. The elevational range is from near sea level at Brownsville, to at least 5,800 ft (ca. 1,770 m) in the Davis Mountains, and to at least 5,500 ft (ca. 1,680 m) in the Chisos Mountains. It coexists with *P. idonea* in the Chisos Mountains (Sanderson, 1948).

Type specimens: Horn (1887) gave the following distributional data for the type material: "occurs in Texas and New Mexico (Prof. Snow)." We have examined the syntype series of four specimens in the Horn Collection (MCZ). Data on labels and attachments to the specimens' pins are given below separated by slashes; attachments and our comments are enclosed in brackets.

The first specimen is a male: Tex [printed]/♂ [printed]/L. ignava Horn [hand-written]/TYPE No. 3688 Lachnosterna ignava G. H. Horn [printed and hand-written

on red]/G. H. Horn Collection [printed]/[microvial containing male genitalia]/lectotype Lachnosterna ignava Horn, desig. Riley & Wolfe, 1992 [printed on red].

The second specimen is a female: Tex [printed]/[an illegible, hand-written name which could be read as "Fuller"]/[cork stub with female genitalic plates affixed]/[small square of red paper]/Para-Type 3688.2 [printed and hand-written on green]/G. H. Horn Collection [printed].

The third specimen is a male: New Mexico F. H. Snow [printed]/♂ [printed]/Para-Type 3688.3 [printed and hand-written on green]/G. H. Horn Collection [printed]/[microvial containing male genitalia]/Phyllophaga idonea Sanderson, Det. Riley & Wolfe, 1992 [printed on white].

The fourth specimen is a male: New Mexico F. H. Snow [printed]/Para-Type 3688.4 [printed and hand-written on green]/Phyllophaga ignava (Horn) 13555 Det. A. A. Granovsky 1939 [printed]/G. H. Horn Collection [printed].

The "type" and "paratype" labels attached to the pins of the above specimens are of no nomenclatorial significance because Horn did not designate type specimens and a previous lectotype designation has not been published for *P. ignava.* To eliminate the potential for future confusion and to fix the usage of the name *ignava* consistent with the concept held by Sanderson (1948), the first and previously dissected syntype is hereby designated as lectotype. Upon dissection, the third syntype was determined to be P. idonea Sanderson. It was discovered that the abdomen of the fourth syntype had been previously removed and the genitalia were missing. This specimen, as well as the female specimen, are not designated as paralectotypes because their identity could not be determined.

Locality records: (Fig. 13) Given below are the localities from specimens of *P. ignava* which we have examined. Identifications were confirmed by dissection of at least one male from each series.

UNITED STATES: NEW MEXICO: *Eddy Co.,* Sitting Bull Canyon; Guadalupe Mts., Dark Canyon, 6,200 ft. *Otero Co.,* Dry Canyon E of Alamogordo, 6,000 ft. TEXAS: *Atascosa Co.,* 5 mi W Campbellton. *Bandera Co.,* Lost Maples St. Pk. *Bexar Co.,* San Antonio, Friedrich Park. *Brewster Co.,* Alpine; Big Bend Natl. Pk., Green Gulch; BBNP, The Basin; BBNP, Maple Cyn., 5,200′; BBNP, Grapevine Hills Campgrd., 29°24′N; 103°11′W; BBNP, North Rosillos Mts., Buttrill Spring; Stillwell RV Park. *Burnet Co.,* Inks Lake St. Pk. *Cameron Co.,* Sabal Palm Grove. *Comal Co.,* nr. Boerne; 12 mi. N New Braunfels. *Crockett Co.,* Pecos River at hwy. 239. *Culberson Co.,* Guadalupe Peak Natl. Pk., Pine Springs. *Duval Co.,* 3 mi S. Freer. *El Paso Co.,* Hueco Tanks St. Pk. *Frio Co.,* 16 mi W Dilley. *Hidalgo Co.,* Bentsen-Rio Grande Valley St. Pk. *Jeff Davis Co.,* Davis Mts. St. Pk.; Fort Davis; 1 mi W, 4 mi W, 11 mi W & 28 mi W Fort Davis; Davis Mts. Resort, 5,800′ (D. Marqua residence). *Kerr Co.,* Double L. Ranch, 6 mi N Kerrville; Kerrville; Kerrville-Schreiner St. Pk. *Kimble Co.,* South Llano Riv. St. Pk. *Menard Co.,* Menard. *Presidio Co.,* Big Bend Ranch St. Nat. Ar., Madera (Monilla) Cyn. Riv. Acc.; BBRSNA, Colorado Cyn. Riv. Acc.; Fort Leaton St. Hist. Site; 12.5 mi W Lajitas; Presidio; Redford. *San Patricio Co.,* Lake Corpus Christi St. Pk. *Sutton Co.,* Sonora. *Terrell Co.,* Jct. Independence Ck. & hwy. 349. *Tom Green Co.,* Christoval. *Uvalde Co.,* 65 Km W Uvalde. *Val Verde Co.,* Dolan Creek Campgrd., 29°54′N: 100°53′W; Rio Grande at Langtry; Seminole Canyon St. Pk.

MEXICO: CHIHUAHUA: hwy. 49, 21 mi SE Cd. Jimenez, 1.6 NE on m-wave rd., 4,720 ft; hwy 45, 23 mi SW Cd. Jimenez, 5,050 ft COAHUILA: Carrizo Wash, 25 mi W Muzquiz; Burro Mt., San Esteban. DURANGO: hwy. 45, 5 mi N Rodeo, 6 mi W, 4,980 ft.
Flight period in Texas (collections per month): April (6), May (7), June (26), July (12), August (9), September (2).

Phyllophaga (*s. str.*) *idonea* Sanderson
(Fig. 3)

Phyllophaga idonea Sanderson, 1948:1.

The confusion surrounding the identification of this species and *P. ignava* is discussed above under *P. ignava.* The characters distinguishing *P. idonea* from the two new species, *P. invisa* n. sp. and *P. rolstoni* n. sp., are discussed under those species. From *P. ignava,* it differs in the shape of the parameres, specifically by the double or figure eight-shaped distal opening (fig. 3), instead of a simple, round to ovoid opening, and by having sclerotized armature on the internal sac of the aedeagus. *Phyllophaga idonea* is the only member of the *ignava* group which possesses armature on the internal sac other than the broad band of microspines common to all species of the group. This armature consists of a single recurved, tooth-like structure positioned on a sclerotized plate on the dorsal side of the internal sac.
Range: Texas (Chisos Mts.), New Mexico and Arizona. Thus far, *P. idonea* has not been taken in Texas outside the Chisos Mts., but it is confirmed for New Mexico and several locations in Arizona (see below). It was not recorded from Mexico (Morón, 1986), although we expect it to occur in northern Mexico in environs similar to the Chisos Mts.
Habitat: Oak-pine-juniper associations at elevations from 5,000 to 6,500 ft (ca. 1,500 to 2,000 m) in the Chisos Mountains. It coexists with *P. ignava* at the type locality, Juniper Canyon, Chisos Mts. (Sanderson, 1948). Butler and Werner (1961) list as hosts for *P. ignava* (which we believe is a misidentification of *P. idonea*), *Quercus gambelii* Nutt., *Q. oblongifolia* Torr. and *Q. turbinella* Greene. William Warner has associated *P. idonea* with *Q. turbinella* in Arizona, but has not observed feeding (personal communication, 1992).
Locality records: (Fig. 13) Given below are the localities from specimens of *P. idonea* which we have examined. Identifications were confirmed by examination of male genitalia.
ARIZONA: *Gila Co.,* Sierra Ancha Mts., Parker Cyn.; Sierra Ancha Mts., Workman Creek. *Graham Co.,* Gailuro Mts., High Creek, 1660 m. *Maricopa Co.,* Jct. Fish Ck. Cyn. & Apache Trail; Seven Springs Campground; Sunflower, Sycamore Ck., 1200 m. *Pima Co.,* Mt. Lemmon (lower edge of oak zone). *Pinal Co.,* Devil's Cyn. & US Hwy. 60. *Yavapai Co.* Hassayampa Riv., 5,040 ft. NEW MEXICO: no further data. TEXAS: *Brewster Co.* Chisos Mts., Juniper Canyon (paratypes); Chisos Mts., Pine Canyon, 6,500 ft.
Flight period in Texas (collections per month): June (1), July (2).

Phyllophaga (*s. str.*) *invisa* **n. sp.**
(Figs. 1, 5, 6, 10)

General: Oblong-elongate, sides parallel; length/width = 2.0–2.1; Length, males 16.6–19.0 mm; females 17.3–21.1 mm. (for length variation, see fig. 12). Maximum width, males 7.7–9.2 mm; females, 8.6–9.9 mm. Dorsum glabrous, glossy; coloration distinctly two-tone: head and pronotum dark reddish brown, elytra light to medium reddish brown, distinctly lighter than head and pronotum. Venter, including legs, dark reddish brown, abdominal sterna a slightly lighter shade of reddish brown. **Head:** Clypeal margin narrowly reflexed throughout, weakly emarginate medially; surface little impressed behind margin, evenly punctate; punctures ovate, simple and closely spaced, separated on average by distance less than maximum diameter. Frontoclypeal suture distinct throughout length, not interrupted by punctation, sinuate. Punctation of frons similar to that of clypeus, ending abruptly on vertex, at least medially, leaving a smooth, impunctate band across base of head (visible in repose), at least a few punctures present laterally in this area near eyes. Head width/interocular distance = 1.5 to 1.7 in males, 1.5 to 1.6 in females. Antenna 10-segmented; male club length/funicle length = 2.0 to 2.4; female club distinctly shorter than male, female club length/funicle length = 1.1 to 1.2. **Pronotum:** 1.5 to 1.7 times as wide as long; anterior margin nearly straight from side to side with distinct, elevated, flat marginal bead which is crenate internally; posterior margin faintly arcuate, margined and with a line of closely placed punctures. Lateral margin broadly rounded at midlength, tapering and weakly sinuate before anterior and posterior angles, more strongly so posteriorly; bead distinct, interrupted by crenations which are graded from strong and distant anteriorly to fine and closely spaced posteriorly; marginal setae few, small and inconspicuous. Anterior angle obtuse, not projected; posterior angle acute, weakly projected. Disc evenly convex from side to side, vaguely flattened in anterolateral region, rather abruptly declivous before posterolateral margin; punctation more or less evenly spaced, less dense just before lateral and hind margins, punctures along anterior margin and on anterolateral area a little more crowded and slightly smaller than those on mesal region. Punctures round, subequal to or slightly larger than those on frons, each seated within shallow impression, intervening areas weakly convex. **Scutellum:** Sparsely punctate, punctures slightly smaller than those on pronotum, placed irregularly but most frequent along basal and lateral margins. **Elytron:** Broad, sutural costa distinct, other costae obscure; lateral margin with fringe setae small and inconspicuous, hidden anteriorly from dorsal view by umbone. Punctation on disc more or less regularly spaced; punctures slightly smaller than those of pronotal disc, each seated within vague impression as on pronotum, separated on average by spaces approximately twice their diameter. **Venter:** Metasternum and hind coxal plate rather closely and uniformly punctate; pubescence of metasternum moderately long, sparse. **Legs:** Lower spur of hind tibia articulated in both sexes; both spurs of male narrow, weakly curved, apices narrowly rounded; upper spur longer than first tarsal segment, first tarsal segment length (FTSL)/upper spur length (USL) = .73 to .89; lower spur shorter than first tarsal segment, FTSL/lower spur length (LSL) = 1.25 to 1.6. Hind tibial spurs of female as in male except slightly broader, upper spur longer than first tarsal segment, FTSL/USL = .71 to .74; lower spur equal in length to first tarsal segment. Tarsal claws weakly curved in

male, a trifle more strongly curved in female; tooth moderate in size, positioned slightly before the middle of claw. **Abdomen:** Similar between males and females; mesal region of visible sterna 2–5 of male very slightly flattened; sternum 6 short, unmodified. **Genitalia:** male (Figs. 5, 6): symmetrical; ventral surface of base simple, without elevated lobes. Parameres narrowed distally, apices narrowly separated in en-face view; distal opening single, ovoid, drawn-out proximally to narrow point. Apex of paramere in lateral view simple and narrow, evenly curved ventrad. Aedeagus membranous except for sclerotized pair of subparallel apodemes which are fused distally. Internal sac simple, without sclerotized armature, narrow proximally and distinctly swollen distally; a broad band of microspines encircling most of swollen area and part of narrow portion of sac. Female (Fig. 10): major setae on apical portions of superior and inferior plates less numerous and shorter than seen in other species of the group.

Holotype: TEXAS: Kenedy Co., 5 mi. S Sarita, VI-15-1990, C. S. Wolfe, collected at UV light. A male with genitalia contained in a glycerine-filled microvial, aedeagus and internal sac distended. Deposited in the Texas A&M University Collection [TAMU].

Allotype: Same data as above. A female with genitalic plates in glycerine-filled microvial, deposited in TAMU.

Paratypes: (430 total), deposited at American Museum of Natural History, California Academy of Sciences, Canadian Museum of Nature, Florida State Collections of Arthropods, Illinois Natural History Survey, Museum of Comparative Zoology, Louisiana State University, Texas A&M University, United States National Museum of Natural History, and several private collections.

TEXAS: *Aransas Co.,* Goose Island St. Pk., VI-7-1983, D. A. Rider & C. B. Barr [8♂♂, 1♀]; Rockport, VIII-10-1985, S. J. Hanselman, at street lights [1♀]. *Atascosa Co.,* 12 mi S Lytle, V-26-1994, Wm. Godwin & R. Gibson, BL [11♂♂, 4♀♀]; Pleasanton, VI-15-1985, D. W. Sundberg [1♂, 1♀]. *Bastrop Co.,* Bastrop, VII-2-1978, O. E. Hunt [1♂]; 6 mi E Bastrop, VII-13-1985, D. W. Sundberg [1♂, 1♀]; Bastrop St. Pk., VII-7-1989, E. G. Riley [10♂♂]; VII-21-1989, E. G. Riley & C. S. Wolfe, UV light [4♂♂]; VI-20-1990, MV & BL light [14♂♂]; VII-17-1991, C. S. Wolfe, UV light [2♂♂]; VI-25-1990, E. G. Riley, S. Lingafelter & R. Vogtsberger, at UV light [5♂♂]. *Bexar Co.,* I-37 2 mi S Jct. 1604, VIII-19-1988, D. W. Sundberg, blacklight [12♂♂, 1♀]; I-37 & Mathis rd., Waterwood Estates, VII-2-1988, D. W. Sundberg [5♂♂]; V-1991, D. W. Sundberg [15♂♂]; Mathis, VI-4-1988, D. Sundberg [3♂♂, 2♀♀]. *Brooks Co.,* rest stop, 7.3 mi S Falfurrias on hwy. 281, V-8-1989, E. G. Riley, at light [1♂]; V-4-1989, C. S. Wolfe, at lights [1♂]; V-25-1989 [3♂♂, 1♀]; V-13-1990 [4♂♂, 1♀]; VI-13-1990 [17♂♂, 6♀♀]; VII-18-1991 [23♂♂, 7♀♀]; IX-5-1992 [1♂, 4♀♀]; 8 mi. S Falfurrias, IX-12-1987, E. G. Riley, at lights [10♂♂, 13♀♀]; IX-2-1989, D. J. Heffern, lights [1♂]; VIII-7-1992, [2♂♂]; IX-19-1992, D. B. Thomas [2♂♂, 1♀]. *Caldwell Co.,* ca. 5 mi E McMahan, VI-3-1994, Wm. Godwin [1♂]. *Kenedy Co.,* 5 mi S. Sarita, VI-13-1990, C. S. Wolfe, collected at UV light [holotype & allotype, 17♂♂, 11♀♀]; VI-15-1990 [5♂♂, 1♀]; 6.2 mi S. Sarita, V-2-1991, C. S. Wolfe, UV light [1♂]; V-20-1991 [5♂♂, 1♀]; VI-19-1992, [16♂♂, 6♀♀]; IX-6-1992 [3♂♂, 2♀♀]. *Kleberg Co.,* Padre Island (North), outside Natl. Pk. gate, VIII-27-1988, D. W. Sundberg, blacklight [10♂♂, 1♀]; North Padre Island, VI-20-1992, C. S. Wolfe, UV light [64♂♂, 25♀♀]. *Leon Co.* 5 mi N Flynn, VII-

11-1993, E. G. Riley, UV light [5♂♂]; VII-16-1993, H. & A. Howden [2♂♂]. *Medina Co.,* Devine, VI-12-1975 [1♂]. *Milam Co.,* Sugar Loaf Mt., 4 mi N Gause, 500′, VII-21-1992, Godwin & Gibson, BL [2♂♂, 1♀]; VII-22-1992, Godwin & Riley, MV & BL [12♂♂, 1♀]; same locality, except 350′, VII-30-1992, Wm. Godwin, BL [23♂♂]. *San Patricio Co.,* Welder Wdlf. Ref., 17 km NE Sinton, V-17-25-1985, H. & A. Howden, C. Scholtz, on Sesbania drummondii, blacklight, dung-carrion traps [5♂♂, 4♀♀]; Welder Wdlf. Ref. VII-18-1988, J. C. Schaffner [1♂]; WWR, hackberry woodland, VI-19-1989, J. M. Mora, pit-fall trap [1♂]. *Starr Co.,* La Gloria, IX-26-1992, D. B. Thomas [1♀].

Etymology: From the Latin *invisus,* meaning unseen.

Comparative remarks: This is the only species of the *ignava* species group which can be confidently determined by external characters. It is separated from the other species of the group by its larger size (see Fig. 12), two-tone dorsal coloration, and the small and inconspicuous fringe setae of the elytra, particularly those below the umbone which are small enough to be completely hidden from dorsal view. In the two previously described species and *P. rolstoni* n. sp., the average body length is smaller, dorsal coloration is nearly one continuous red-brown tone, and the fringe setae of the elytra are long and conspicuous, especially those below the umbone. The shape of the distal opening of the male genitalia of *P. invisa* differs slightly from that of *P. ignava* (see Figs. 1, 2).

Range: (Fig. 13) Confined to south and east-central Texas where it occupies the easternmost portion of the range of the *ignava* species group. The easternmost localities are in Leon County in the north, and Aransas County on the Gulf coast. It is known from as far south as the northern portion of Starr County, but it does not reach the delta of the lower Rio Grande valley. The westernmost locality is in Medina County. The ranges of *P. invisa* and *P. ignava* appear to narrowly overlap in a zone to the south and southeast of Bexar County. Localities where both species coexist are not presently known.

Habitat: *P. invisa* occurs most abundantly, and perhaps exclusively, in areas with very sandy soils. At the southern localities in Kenedy and Brooks Counties, it is associated with the introgressed hybrid oak, *Quercus fusiformis* Small X *Q. oleoides* Cham. & Schlecht., but we have not observed it feeding on this oak or on any other plant species. It has been taken twice in large numbers at treeless areas on North Padre Island in Kleberg County. Localities to the north are also sandy but with dense, mixed oak-pine forest (Bastrop County) or primarily oak (Milam Co.). The elevational range for *P. invisa* is from near sea level to approximately 650 ft. (ca. 200 m) at Devine, Medina Co.

Flight period (collections per month): May (9), June (13), July (13), August (4), September (6).

Phyllophaga (s. str.) rolstoni n. sp.
(Figs. 4, 7–9, 11)

General: Oblong-elongate, sides parallel; length/width = 2.1; Length, males 13.1–15.7 mm; female 14.8 mm. (for length variation, see Fig. 12). Maximum width, male 6.1–7.2 mm; female 7.2 mm. Dorsum glabrous, glossy; dorsal coloration uniform, medium reddish brown. Venter and legs reddish brown, metathorax and abdominal

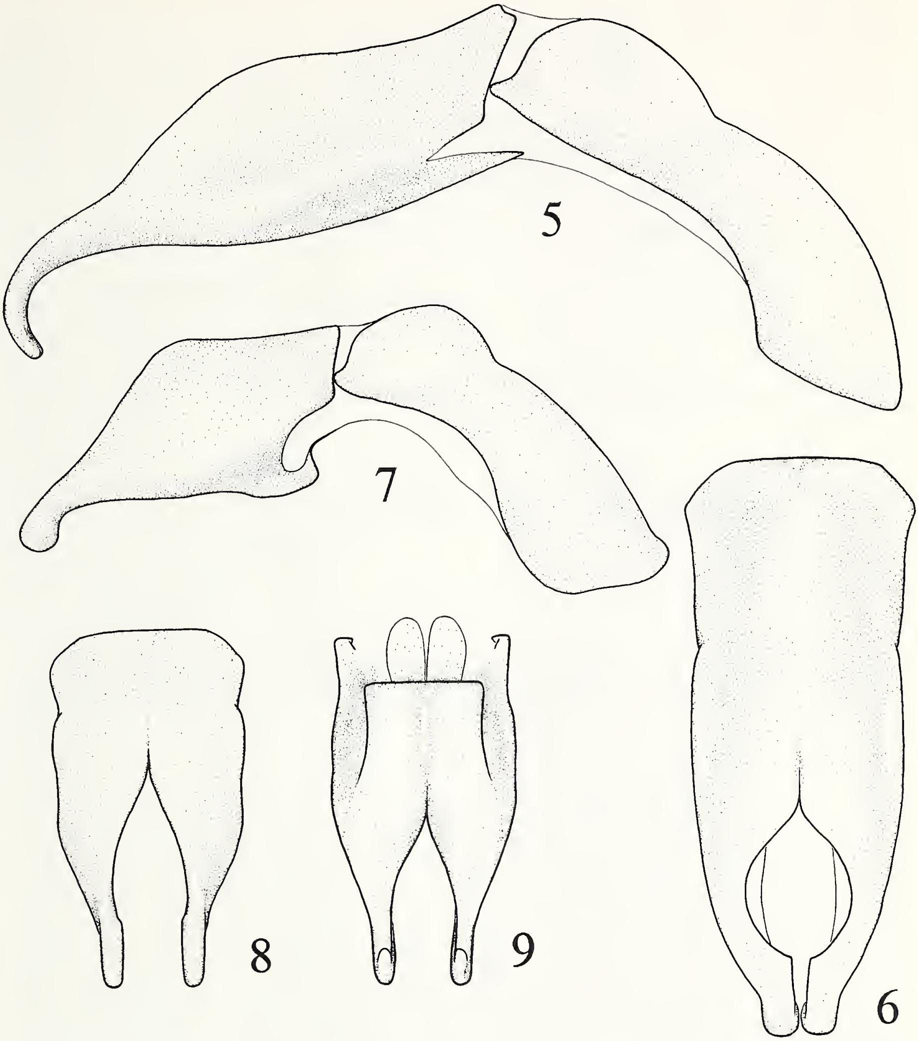
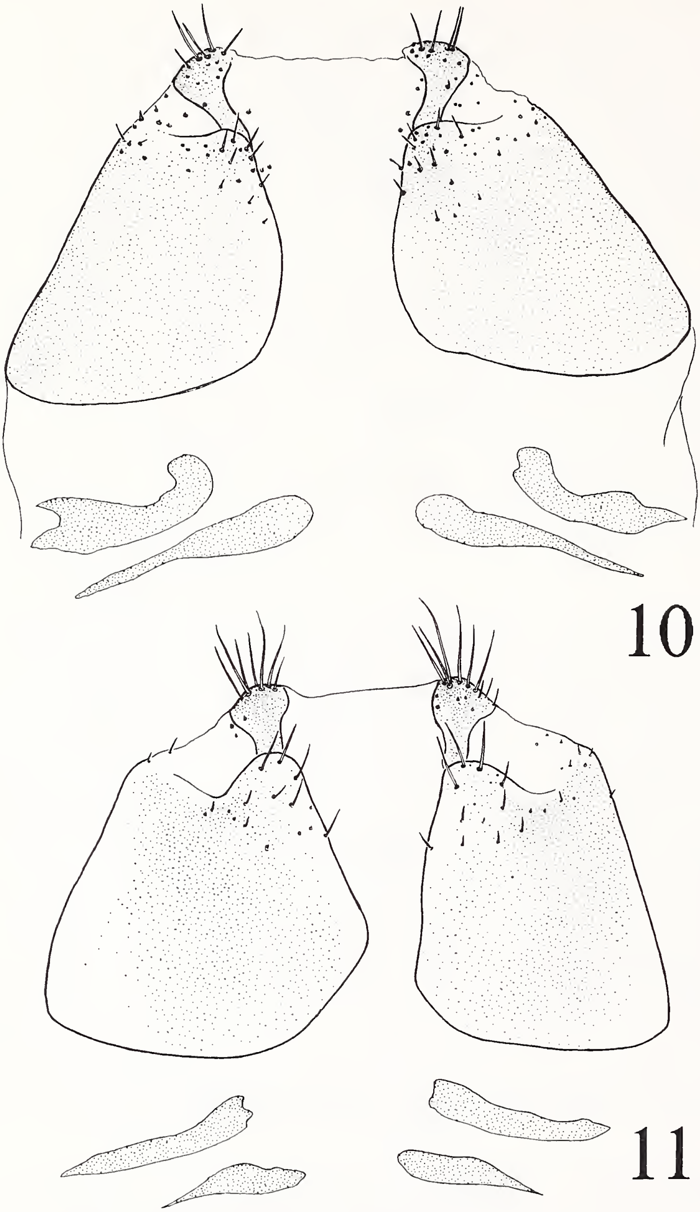


Fig. 5–9. Parameres and basal piece of *Phyllophaga* n. spp. 5, 6, *P. invisa* n. sp., en-face and lateral. 7–9, *P. rolstoni* n. sp., en-face, lateral and ventral.

sterna a lighter shade of reddish brown. **Head:** not differing appreciably from description of *P. invisa,* except punctation on clypeus and frons slightly more dense. Head width/interocular distance = 1.7 to 1.8 in males; 1.5 in female. Antenna 10-segmented; male club equal to 1.6 to 1.8 times length funicle; female club distinctly shorter than in male, equal to 1.1 times length of funicle. **Pronotum:** 1.6 times as wide as long, punctures somewhat less dense and less deeply impressed, otherwise not differing appreciably from description of *P. invisa.* **Scutellum** and **Elytra:** as described for *P. invisa* except marginal fringe setae long and distinct, easily viewed



Figs. 10, 11. Female genitalic plates, ventral view. 10, *Phyllophaga invisa* n. sp. 11, *Phyllophaga rolstoni* n. sp. Drawn from slide-mounted specimens, many small setae and sensilla not shown. Degree of stippling indicates degree of pigmentation.

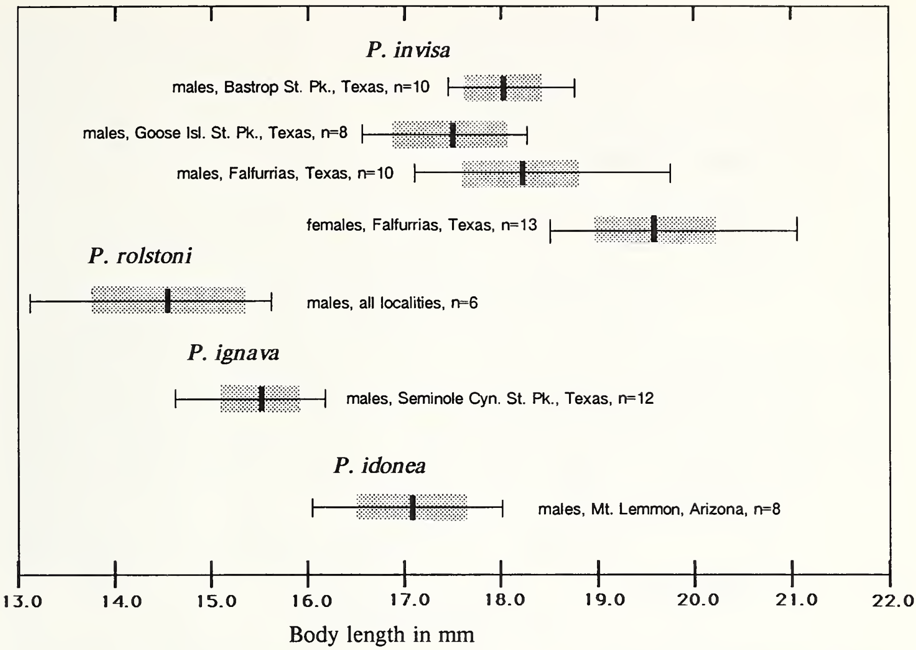


Fig. 12. Body length variation in species of the *ignava* species group. Horizontal line = range, vertical bar = mean, shaded rectangle = ± one standard deviation.

from above, those below umbone longest. **Venter** and **abdomen:** as described for *P. invisa.* **Legs:** Lower spur of hind tibia articulated in both sexes; spurs of male narrow, weakly curved, apices narrowly rounded; upper spur subequal in length to first tarsal segment, first tarsal segment length (FTSL)/upper spur length (USL) = 0.95 to 1.1; lower spur shorter than first tarsal segment, FTSL/lower spur length (LSL) = 1.43 to 1.83. Female with upper spur slightly longer than first tarsal segment, FTSL/USL = 0.9; lower spur shorter than first tarsal segment, FTSL/LSL = 1.27. Tarsal claws weakly curved in male, a trifle more strongly curved in female; tooth moderate in size, positioned slightly before the middle of claw. **Genitalia:** male (Figs. 7–9): symmetrical; ventral surface of base with pair of broad, proximally-directed lobes, apex of each lobe truncate with rounded external angle; each lobe undercut by intrusion of ventral membrane; a pair of broad, sclerotized plates extend proximad into ventral membrane from proximal margin of lobes. Parameres strongly narrowed distally, apices widely separated in en-face view; distal opening elongate oval, drawn-out proximally into long, narrow point, very weakly constricted preapically and remaining broadly open distally. Apex of paramere in lateral view narrow, deflexed ventrally to form a short, rounded lobe. Aedeagus lacking sclerotization except for pair of subparallel apodemes which are joined by weakly sclerotized strip for most of their length, bifurcate and weakly divergent distally. Internal sac of aedeagus elongate-tubiform, fairly uniform in width except a little more swollen

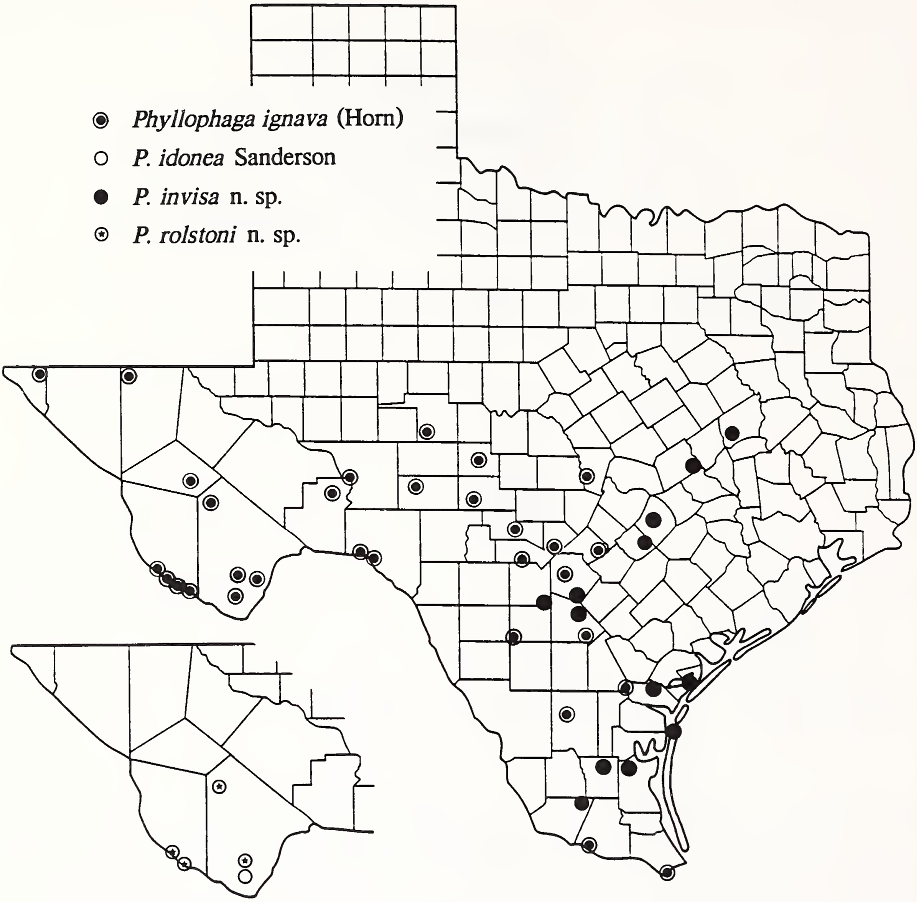


Fig. 13. Distribution records for species of the *ignava* species group. Each symbol represents one locality or more than one approximate localities from which the authors have seen specimens. Only Texas localities shown for *P. ignava.*

apically, without sclerotized armature; distal portion encircled with broad band of microspines. Female (Fig. 11).

Holotype: TEXAS: Presidio Co., Big Bend Ranch State Natural Area, Madera (Monilla) Canyon River Access, VI-5-1992, E. Riley & W. Godwin, UV light. A male with genitalia in glycerine-filled microvial, aedeagus and internal sac distended. Deposited in TAMU.

Allotype: TEXAS: Presidio Co., Big Bend Ranch State Natural Area, Colorado Canyon River Access, VI-10-1992, C. S. Wolfe, at blacklight. A female with genitalic plates in glycerine-filled microvial, deposited in TAMU.

Paratypes: (6 total) deposited in collections of TAMU, Sul Ross State University, Riley, Warner and Wolfe.

Same locality as allotype, VI-5-6-1992, E. Riley & C. Wolfe, UV light [3♂♂];

TEXAS: *Brewster Co.,* Alpine, NE of Sul Ross Sci. Bldg., close to greenhouse #12, 06-05-81 [1♂]; Alpine, Dorm, 06-05-88, Mark Lockwood [1♀]; Rosillos Mts., Buttrill Spring, VII-30-1987, D. J. Heffern, UV light [1♂].
Etymology: This species is dedicated to Lawrence Rolston who served as the first author's graduate advisor and suggested study of *Phyllophaga* as a thesis topic.
Comparative remarks: On average, *P. rolstoni* is the smallest member of the *ignava* species group (see fig. 12). It is easily separated from *P. invisa* by external characters (see discussion above), but is easily confused with *P. ignava* and *P. idonea.* From the latter two species it is best distinguished by the shape of the parameres which are considerably different, possessing broad, proximally-directed lobes beneath at their base. Unlike all other species of the group, the apices of the parameres are well separated, not enclosing the distal opening.
Range: (fig. 13) Known only from the Big Bend region of western Texas from the Rio Grande north to Alpine. It coexists with *P. ignava* at all known stations.
Habitat: Taken in ravines and riparian areas along the Rio Grande, at desert springs, and in disturbed areas (the campus of Sul Ross St. Univ.). Known localities range in elevation from 2,400 ft. (ca. 730 m) to 4,480 ft. (ca. 1,370 m). We have no food plant data.
Flight period (collections per month): June (3), July (1).

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We especially thank David Riskind of the Texas Parks and Wildlife Department for granting permission to collect and study *Phyllophaga* on operational units of the Texas State Park System. We also appreciate the information and specimens provided by several people, especially Wm. Godwin, H. F. Howden, S. McCleve, D. B. Thomas, and W. B. Warner. William Godwin located the Leon and Milam County populations of *P. invisa.* David Furth arranged the loan of G. H. Horn's type material from the Museum of Comparative Zoology. Horace Burke provided a helpful review of the manuscript.

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